# A GUIDE

TO THE

# FOSSIL INVERTEBRATES AND PLANTS

IN THE DEPARTMENT OF

# GEOLOGY AND PALÆONTOLOGY

IN THE

# BRITISH MUSEUM (NATURAL HISTORY),

CROMWELL ROAD, LONDON, S.W.

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WITH 182 ILLUSTRATIONS.

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*PRINTED BY ORDER OF THE TRUSTEES.*

1897.



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British Museum (Nat. Hist.). Dept. of Geology

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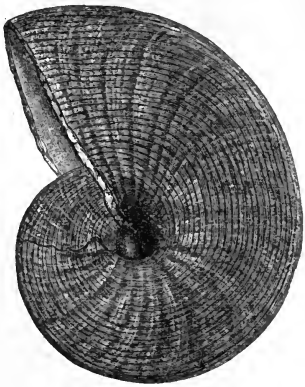

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HERTFORD:
PRINTED BY STEPHEN AUSTIN AND SONS.

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# LIST OF ILLUSTRATIONS.

# PREFACE.

In the earlier Guides to the Geological Department the great section of the Invertebrata, the Fossil Plants, the Historical and Stratigraphical collections occupied not more than 24 pages with their description. The work of naming, preparing, and arranging the infinite number of specimens exhibited in the four Galleries devoted to these collections, has only of late been so far completed as to admit of a full account being prepared. Many years of detailed work are still required to perfect this extensive series.

In the preparation of this new Guide I have been most kindly assisted in the Cephalopoda by Dr. A. H. Foord and Mr. G. C. Crick; in the other Mollusca, by Mr. R. Bullen Newton and Mr. G. F. Harris; in the Brachiopoda, Echinoderma (general), Cystidea, Blastoidea, and the Crinoidea, by Mr. F. A. Bather; in the Bryozoa, Echinoidea, Asteroidea, Ophiuroidea, Cœlentera, and Vermes, by Dr. J. W. Gregory; in the Porifera, Radiolaria, and Foraminifera, by Dr. G. J. Hinde; in the Fossil Plants, by Mr. A. C. Seward; and in the general arrangement, by Mr. A. Smith Woodward.

Thanks are also due to the Delegates of the Clarendon Press, University of Oxford; the Palæontographical Society; to Messrs. A. and C. Black; to Messrs. William Blackwood and Sons; to Messrs. Cassell and Co., and to Messrs. Macmillan and Co., for the loan of many of the illustrations used in this Guide.

HENRY WOODWARD.

Geological Department.
*16th February*, 1897.

# TABLE OF STRATIFIED ROCKS.

| Periods. | | SYSTEMS. | FORMATIONS. | LIFE-PERIODS. |
|---|---|---|---|---|
| CAINOZOIC. | Quaternary. | RECENT | Terrestrial, Alluvial, Estuarine, and Marine Beds of Historic, Iron, Bronze, and Neolithic Ages | Dominant type, Man. |
| | | PLEISTOCENE (250 ft.) | Peat, Alluvium, Loess<br>Valley Gravels, Brick-earths<br>Cave-deposits<br>Raised Beaches<br>Palæolithic Age<br>Boulder-clay and Gravels | |
| | Tertiary. | PLIOCENE (100 ft.) | Norfolk Forest bed Series<br>Norwich and Red Crags<br>Coralline Crag (Diestian) | Dominant types, Birds and Mammals. |
| | | MIOCENE (125 ft.) | Œningen Beds Fresh-water, etc. | |
| | | EOCENE (2,600 ft.) | Fluvio-marine Series (Oligocene)<br>Bagshot Beds / London Tertiaries (Nummulitic Beds) | |
| SECONDARY OR MESOZOIC. | | CRETACEOUS (7,000 ft.) | Maestricht Beds<br>Chalk<br>Upper Greensand<br>Gault | Dominant type, Reptilia. |
| | | NEOCOMIAN | Lower Greensand<br>Wealden | |
| | | JURASSIC (3,000 ft.) | Purbeck Beds<br>Portland Beds<br>Kimeridge Clay (Solenhofen Beds)<br>Corallian Beds<br>Oxford Clay<br>Great Oolite Series<br>Inferior Oolite Series<br>Lias | |
| | | TRIASSIC (3,000 ft.) | Rhætic Beds<br>Keuper<br>Muschelkalk<br>Bunter | |
| PRIMARY OR PALÆOZOIC. | | PERMIAN or DYAS (500 to 3,000 ft.) | Red Sandstone, Marl / Magnesian Limestone, etc. (Zechstein)<br>Red Sandstone and Conglomerate Rothliegende | Dominant type, Fishes. |
| | | CARBONIFEROUS (12,000 ft.) | Coal-measures and Millstone Grit<br>Carboniferous Limestone Series | |
| | | DEVONIAN AND OLD RED SANDSTONE (5,000 to 10,000 ft.) | Upper Old Red Sandstone<br>Devonian<br>Lower Old Red Sandstone | |
| | | SILURIAN (3,000 to 5,000 ft.) | Ludlow Series<br>Wenlock Series<br>Llandovery Series<br>May Hill Series | |
| | | ORDOVICIAN (5,000 to 8,000 ft.) | Bala and Caradoc Series<br>Llandeilo Series<br>Llanvirn Series<br>Arenig and Skiddaw Series | Dominant type, Invertebrata. |
| | | CAMBRIAN (20,000 to 30,000 ft.) | Tremadoc Slates<br>Lingula Flags<br>Menevian Series<br>Harlech and Longmynd Series | |
| | | EOZOIC—ARCHÆAN (30,000 ft.) | Pebidian, Arvonian, and Dimetian<br>Huronian and Laurentian | |

Range of Invertebrata and Plants in time

Range of Fishes in time

Range of Amphibia and Reptilia in time

Range of Birds in time

Range of Mammalia in time

# INTRODUCTION.

TO THE

## GUIDE TO THE FOSSIL INVERTEBRATA IN THE GEOLOGICAL DEPARTMENT.

Before visiting the Geological Galleries upon the east side, it is very desirable that the student should have seen and become acquainted with the recent Zoological collections on the west side of the entrance; and, if he would properly understand the structures and characters of animals, he should spend some time in studying the beautiful series of objects in the Introductory Collection, which occupies the cases in the bays or recesses on each side of the great Central Hall.

As an introduction to the Geological Galleries a few words are needed. Geology embraces the investigation of everything connected with the formation and history of the earth which we inhabit, both organic and inorganic. In the Mineralogical Gallery, on the east side, upon the first floor, will be found a very complete exposition of specimens illustrating the nature and properties of rocks and minerals forming so large a part of the earth's crust; but in the Geological Galleries the exhibited series is necessarily confined to some illustrations of the sedimentary and organically-formed rocks, arranged stratigraphically in Gallery XI, and to as complete a series as possible of the remains of the animals and plants which have been entombed in the various deposits which compose the ground beneath us.

These rocks and sediments and the organisms found in them are of very different relative ages (see the Table of Strata), some, like the Cambrian and Silurian, being extremely ancient, and containing only invertebrate forms of life, the species of which are now quite extinct; others, like the Eocene strata, being very rich in remains of all classes of organisms; whilst the later Tertiary deposits often yield abundant evidence of animals very nearly related to those which are living at the present day.

It must, however, be clearly borne in mind by the student that, as a general rule, only the hard parts, or skeletons and shells, of the animals which are found buried in the soils and rocks composing the earth's crust, are preserved in a fossil state; if, therefore, we desire to understand what kind of animal is represented by the fossil organism in the rocks, we must know at least a little about its living representatives.

In some instances an attempt has been made, as in the Cephalopoda (Gallery VII), the Brachiopoda, Crustacea, and the Crinoidea (Gallery VIII), to introduce drawings and specimens to illustrate these groups; and it is intended to carry this on still further in other divisions of the Museum.

In this Guide to the Invertebrata a brief account is given of the soft parts of each different class, so that the student, who sees in the Geological Galleries the hard parts of these animals placed before him in a fossil state, may learn from the Guide what was the aspect of the living animals of which they once formed a part.

It may be well to add, that from the delicate and perishable nature of many of the Invertebrata (such as the Nudibranchs and other soft-bodied animals) it is hardly likely that they will ever be found in a fossil state; the zoological series in the Geological Galleries is not therefore complete.

We must also mention that the subdivisions in the Invertebrata should not be compared with those in the Vertebrata, for they represent many divisions each more extensive than the whole of the Vertebrata; the individuals are not so large, but they are greatly superior in numbers, whilst their geological record is vastly more ancient.

H. W.

# GUIDE

TO THE

# FOSSIL INVERTEBRATA.

## I.—MOLLUSCA.

**Mollusca.**

**GALLERIES VII & VIII.**

The Mollusca are soft-bodied, invertebrate animals, provided with a highly glandular skin, and usually protected by a shell.

Fig. 1.—Univalve shell of *Scalaria pretiosa*, Lamk. China.

Part of the skin, or covering, which encloses the soft parts of the animal is reduplicated on one or both sides of the body, it

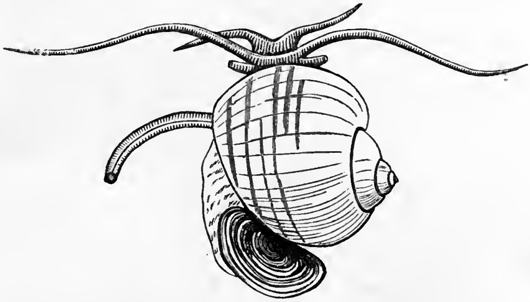


Fig. 2.—Univalve shell of *Ampullaria canaliculata*, Lamk. S. America.

Mollusca.
GALLERIES VII & VIII.

secretes the shell, and is named the *mantle*. The shell may be *univalve*, or in one piece, as in the garden-snail, the whelk, etc.;

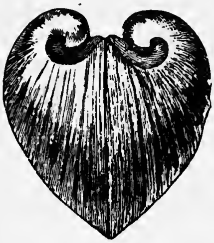


Fig. 3.—Bivalve shell of *Glossus* (*Isocardia*) *cor*, Linn.

or it may be *bivalve*, composed of two parts, as in the oyster, the mussel, the cockle, etc.; or *multivalve*, composed of as many as eight pieces, as in the shell of the *Chiton*. In the

Fig. 4.—Multivalve shell of *Chiton squamosus*, Linn.

bivalves the mantle is divided into two lobes; in the univalves it takes the form of a sac, with an opening in front.

Fig. 5.—*Helix desertorum*, Forsk., the desert-snail. Egypt.

**Mollusca.**
**GALLERIES VII & VIII.**

The body is never divided into joints or segments, as in insects, crustaceans, and worms. There are typically three pairs of

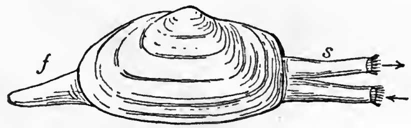



FIG. 6.—*Thracia phaseolina*, Lamk., with its animal. *s*, the incurrent and excurrent siphons marked by arrows; *f*, the foot.

ganglia, or nerve-centres, symmetrically disposed, but the nerves of the visceral loop are much distorted, and usually asymmetrical—at least, in the univalves; but in the bivalves there is a greater approach to bilateral symmetry. There is always an alimentary

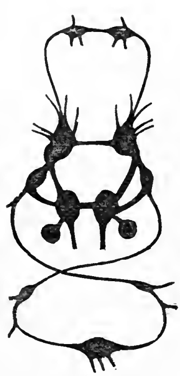


FIG. 7.—Nervous system of *Paludina* or *Viviparus*, a pond-snail.

FIG. 8.—Nerve-ganglia and cords of *Anodonta*, a river-mussel.

canal and, with one doubtful exception,[1] a heart, and more or less distinct respiratory organs.

The Mollusca are divided into two branches—one in which the head is well developed, and the other in which it is atrophied. The former division is now generally known as the GLOSSOPHORA

[1] The genus *Dentalium*.

Mollusca.
ALLERIES
II & VIII.

or Odontophora, the mouth being furnished with a tongue, provided with appropriate muscles, known as the lingual ribbon or *odontophore*, the surface of which is covered by a chitinous

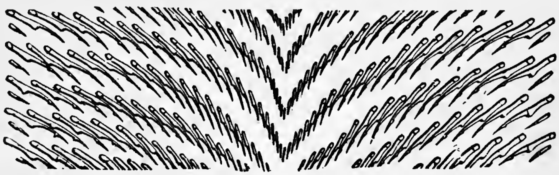


Fig. 9.—Part of the radula of *Testacella haliotoidea.*

membrane beset with minute teeth forming a flexible rasp, or radula. This division includes the Cephalopoda, Scaphopoda, Amphineura, and Gasteropoda. The various members of this


Fig. 10.—Part of the radula of *Auricula*, with central (*c*) and lateral (*l*) teeth and (*u*) uncini more enlarged.

division generally lead an active and sometimes aggressive existence.

The second division, named Acephala (or Lipocephala), includes

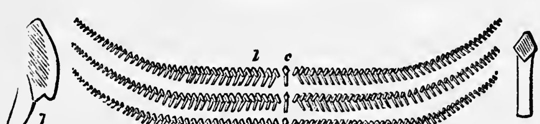



Fig. 11.—Part of the radula of *Siphonaria*, sp., from the Cape. *c*, central teeth; *l*, lateral teeth.

only the Lamellibranchiata. In these the head is aborted; no cephalic eyes are present; and the mouth is destitute of biting,

rasping, or prehensile organs. The members of this division have a bivalved shell, and are either fixed, or sessile, or endowed with very feeble powers of locomotion.

**Mollusca. GALLERIES VII & VIII.**

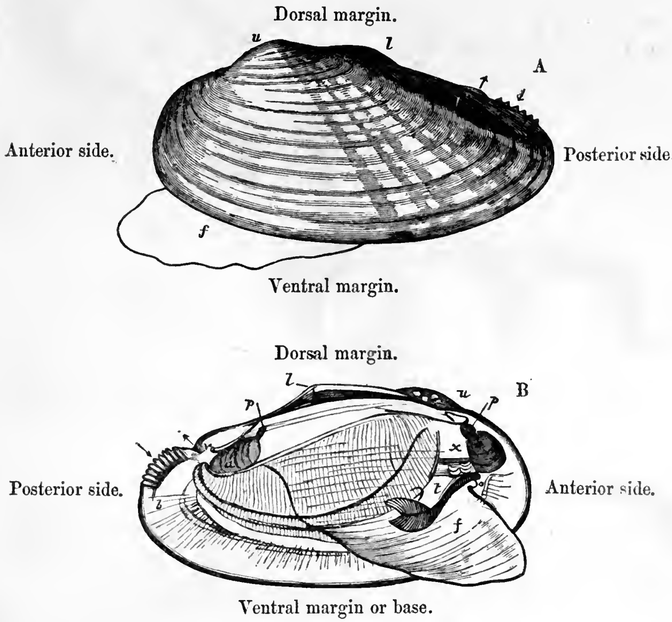



FIG. 12.—The common fresh-water mussel, *Unio pictorum*, Linn. (A) exterior view of left valve; (B) interior view of left valve, showing animal; the right valve is removed. *u*, umbo; *l*, ligament; *o*, the mouth; *p*, *p*, pedal muscles; *a*, *a*, adductor muscles; *f*, foot; *b*, branchial orifice; *v*, anal opening; *t*, palpi. The arrows in both figures indicate the incurrent and excurrent openings.

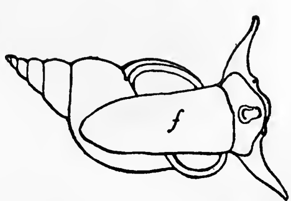



FIG. 13.—View of underside of pond-snail, *Limnæa stagnalis*, Linn., as seen crawling on the side-glass of an aquarium. *f*, the foot.

**Mollusca.**
**GALLERY VII.**

All the Mollusca possess a ventral muscular thickening of the body-wall known as the *foot* (variously developed and modified), which serves as an organ of locomotion. The snail crawls upon its foot; the cockle, and other bivalves, can burrow with their foot, and also transport themselves from place to place under water. The Pteropods ("sea-moths") use the expanded lobes, or wing-like fins of their foot, as swimming-organs.


FIG. 14.—*Cleodora pyramidata*, Linn. Atlantic. *f, f*, expanded wing-like lobes of foot, used by the Pteropods as swimming-organs. (Nat. size.)

## I.—CEPHALOPODA.

The greatest modification is to be met with in the class CEPHALOPODA, which is also the highest division of the Molluscan subkingdom—exemplified by the "Cuttle-fish" and the "Pearly

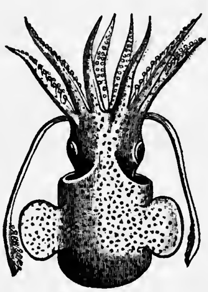


FIG. 15.—*Sepiola Rondeletii*, Gesner. Torbay. (Nat. size.)

Nautilus"—in which the forepart of the foot encircles the mouth and is divided into a series of "tentacles," or feelers,

which assist locomotion, and are also used to seize their prey, **Mollusca.**
whilst the mid-foot is folded together to form a tube or funnel **GALLERY VII.**

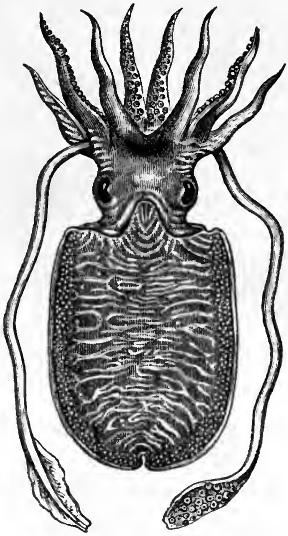


FIG. 16.—*Sepia officinalis*, Linn. British. (½ nat. size.)

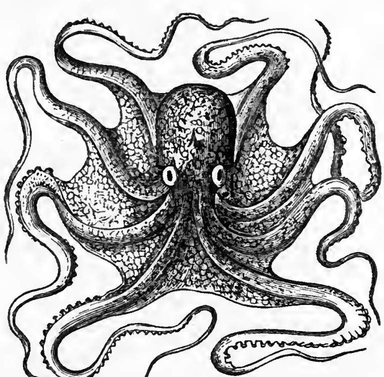


FIG. 17.—*Octopus vulgaris*, Lamarck. Channel Islands. (Much reduced.)

Nautilus. GALLERY VII. Wall-case 1a.

through which the water from the mantle or gill-chamber is forcibly ejected, propelling the animal backwards with rapidity through the water.

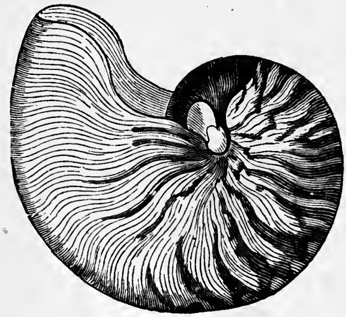


Fig. 18.—Shell of the Pearly Nautilus, *Nautilus pompilius*, Linn. Indian Ocean. (Reduced.)

All the Cephalopoda are marine and predaceous animals, living on other mollusca, crabs, and fishes, and possess considerable powers of locomotion. At the bottom of the sea, and in the rocky pools

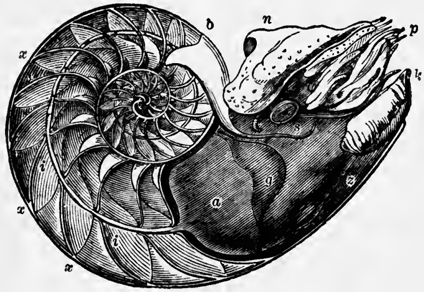



Fig. 19.—Animal of the Pearly Nautilus in its shell. (The shell is cut open.) *a*, the mantle; *b*, the dorsal fold of mantle; *g*, shell-muscle; *i*, *i*, siphuncle; *k*, funnel; *n*, hood; *p*, tentacles; *s*, eye; *x*, *x*, the septa; *z*, last chamber. (Reduced.)

along the shore, they can crawl about head downwards, by means of the tentacles, or feet which surround the mouth, and which are usually furnished with numerous suckers or *acetabula*. They are also able to swim, partly by means of lateral expansions of

the visceral dome, or by fins, but chiefly, as already stated, by the forcible expulsion of water from the respiratory chamber.

**Cuttle-fishes.**
**GALLERY VII.**

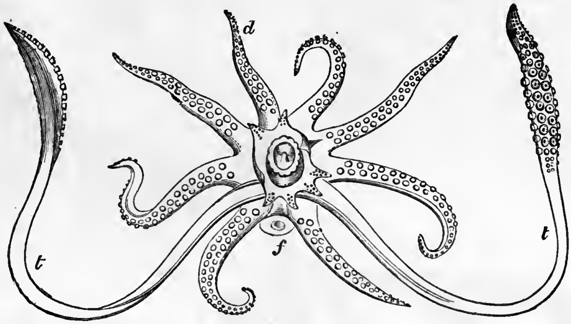



Fig. 20.—Mouth, feet, and foot-tentacles of common squid, *Loligo vulgaris*, Lamk. British coast. *d*, dorsal arms; *f*, funnel; *t*, *t*, tentacles. (Much reduced.)

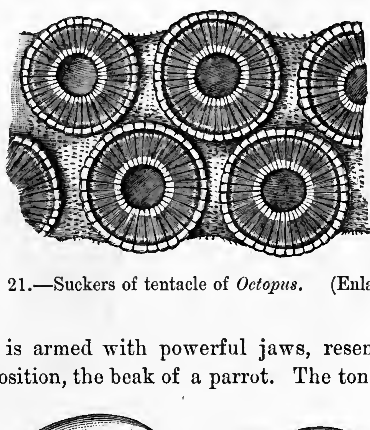


Fig. 21.—Suckers of tentacle of *Octopus*. (Enlarged.)

The mouth is armed with powerful jaws, resembling in form, texture, and position, the beak of a parrot. The tongue is large and

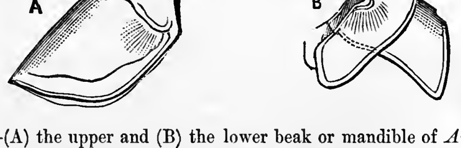



Fig. 22.—(A) the upper and (B) the lower beak or mandible of *Architeuthis monachus*, Steenstrup. (Reduced to one-third nat. size.)

Cuttle-fishes.
GALLERY VII.

fleshy, and in part is armed with lingual teeth similar to those of the snail and whelk. The eyes, except those of *Nautilus*, are large and brilliant, and highly developed, resembling those of the higher vertebrate animals.

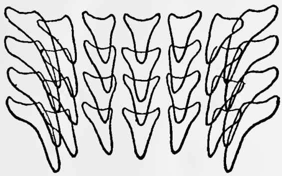


Fig. 23.—Part of the radula of *Sepia officinalis*, Linn. (Magnified.)

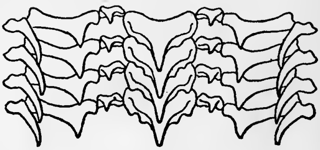


Fig. 24.—Part of the radula of *Octopus vulgaris*, Lamk. (Magnified.)

Although the Cephalopoda seem, at first sight, so different from the other members of the molluscan class, they nearly all possess

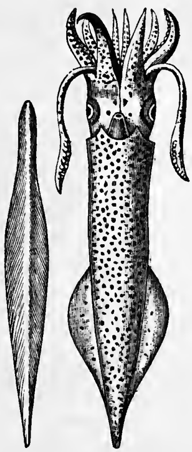



Fig. 25.—(*a*) Internal shell and (*b*) animal of the squid, *Loligo media*, Linn. British coasts. (Reduced.)

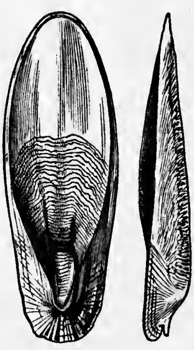


Fig. 26.—Front and side-view of internal shell, or sepiostaire, of the common cuttle-fish, *Sepia officinalis*, Linn. British coasts. (Reduced.)

a shell (or the rudiments of one)—sometimes external, as in the Pearly Nautilus, Fig. 19, but more frequently internal, as in the squids and cuttle-fishes (Figs. 26 and 27)—which serves to protect the more delicate organs of the body, and corresponds

with the external shell commonly met with in all the other **Spirula.** mollusca; and although it is apparently internal in the squids, **GALLERY VII.** cuttles, and calamaries, it is in reality always enclosed in a sac, or a fold, or lobe of the mantle which secretes the shell.

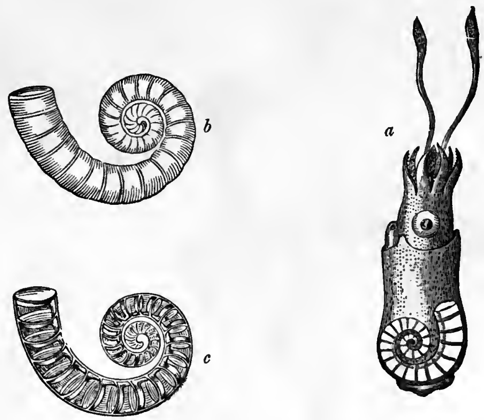



FIG. 27.—*Spirula Peronii*, Lamk. New Zealand. *a*, the animal with the shell *in situ*; *b*, the shell removed from the animal; *c*, the shell laid open to show the septa. (*a*, $\frac{1}{2}$ nat. size; *b*, *c*, nat. size.) **Table-case 57.**

The nervous system is more concentrated than in the other mollusca, and the larger ganglia are protected by a cartilage. The respiratory organs consist of two or four plume-like gills, placed symmetrically on the sides of the body in a large branchial or mantle-chamber opening forwards on the underside of the head: in the middle of this opening is placed the siphon or funnel. The sexes are distinct in all living Cephalopods. In *Nautilus* only, the males are less numerous than the females.

The Cephalopoda have been divided into two orders, based upon the number of the gill-plumes present in each; but they present besides several other important characters by which they can be distinguished and classified.

1.—DIBRANCHIATA (two-gilled division). Cephalopods having the inflected margins of the mid-foot fused together, so as to form a complete tubular funnel. The lobes of the fore-foot, which surround the mouth, carry suckers disposed in rows. They have

**Belemnites.**
**GALLERY VII.**

a single pair of comb-like gills. The oviducts are sometimes paired (right and left), sometimes only one is developed. A horny or calcareous internal shell is developed in most of them, enclosed in a sac formed by the mantle; in the Octopoda the shell is not developed, save in *Argonauta*, the female of which secretes a shell (Fig. 35).

The eyes are very highly-developed organs, with a refractive lens, cornea, and eyelids. They are the most striking organs in

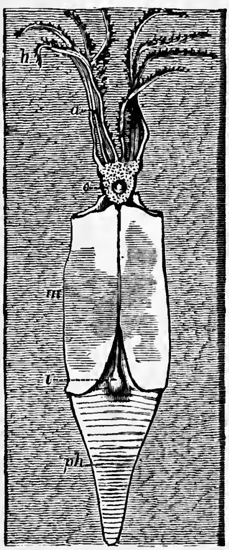


Fig. 28.—*Belemnoteuthis antiqua*, Cunnington. Oxfordian: Christian Malford, Wilts. *h*, hooklets on arms; *m*, mantle; other letters as in Fig. 31.

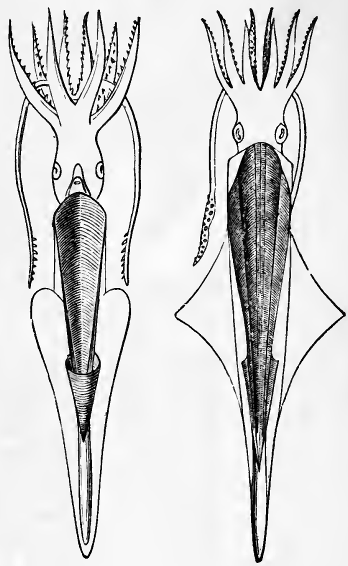


Fig. 29.—Diagrammatic restoration of the animal and shell of Belemnite (after D'Orbigny).

these creatures, being both large and brilliant, and well express the keen activity and alertness for which the majority of this wonderful group is conspicuous.

All the Dibranchiata secrete an inky fluid, and possess an "ink-bag," having a tough and fibrous structure, with a thin,

silvery, outer coat. It discharges its contents through the anus, which opens near the base of the funnel. The inky fluid accumulated in this reservoir can be discharged at will by the animal, and serves to cloud the water for yards around, thus concealing its retreat, and so enabling it to evade its pursuers. Many examples of fossil Dibranchiata are exhibited in the cases, in which the ink-bag is still preserved *in situ.*

**Cuttle-fishes. GALLERY VII. Wall-cases 1 & 1a.**

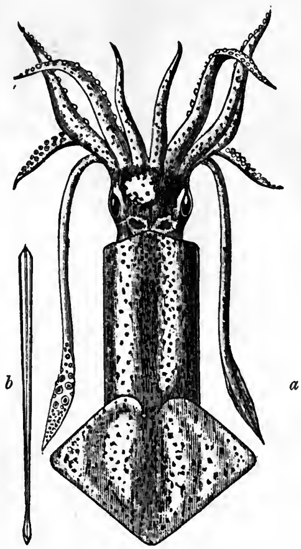



FIG. 30.—*Ommastrephes sagittatus*, Lamk. (British). *a*, the animal; *b*, the internal shell or pen.

The dried ink-bags of cuttle-fishes and squids are regularly collected and prepared by artists' colourmen to form the pigment known as "sepia." The Chinese and Japanese had probably used it both as a pigment and as a writing fluid long ages before it was known in England; and it was so used in Greece in the time of Cicero, B.C. 106.

From their extreme delicacy, the internal shells of Dibranchiate Cephalopods are but seldom preserved in museums. The solid guards of the *Belemnites* (Fig. 31) are very abundant in a fossil state. The internal pens of Teuthidæ are more rare, but occur in the Cretaceous beds of the Lebanon (Fig. 32); in the Lithographic

**Cuttle-fishes.**
**GALLERY VII.**

Stone of Solenhofen, Bavaria; in the Oxford Clay of Wilts; in the Kimeridge Clay; and in the Lias of Lyme Regis, and of Boll, in Wurtemberg. See Wall-case 1 and Table-case 59.

(*a*) Octopoda.—The Octopods (see Fig. 17, p. 7) are characterized by possessing only eight arms furnished with suckers. The section embraces the Argonaut, or "Paper Nautilus," and the Octopus, or

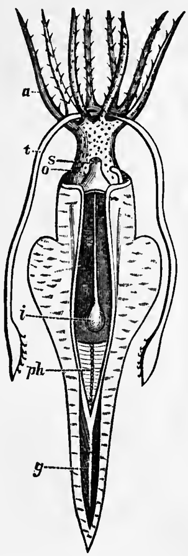



Fig. 31.—Animal of Belemnite (restored by Owen). *a*, the eight ordinary arms with hooks attached; *t*, the tentacular arms; *s*, the siphon; *o*, the eye; *i*, the ink-bag; *ph*, the phragmocone; *g*, the guard.

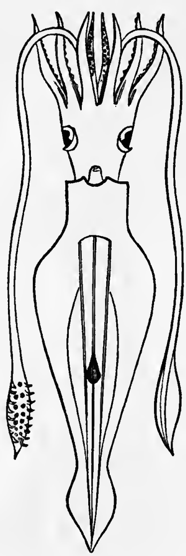


Fig. 32.—*Plesioteuthis* (*Dorateuthis*) *Syriaca*, H.W., sp. Cretaceous: Lebanon. Wall-case 1. Showing internal shell and ink-bag near the centre of body. (Nat. size.)

"Devil-fish." The Argonaut (*Argonauta argo*, Linn.), about which many pretty, but fabulous, stories have been told, was the *Nautilus primus* of Aristotle. The shell is only developed in the female, the male being destitute of any calcareous covering. The Argonaut swims backwards by ejecting water from its funnel, like the cuttle-fishes (Fig. 34). The two supposed "sails" are the expanded lobes of the pair of displaced and flexed (shell-secreting) arms. The shell is not actually attached to the body, and the animal has

**Argonauts** **GALLERY VII.**

been observed, when injured, to vacate its shell; neither is the shell actually *external*, being always enveloped, for the greater part, by the lobe-like expansions of the shell-secreting arms (Figs. 35*a*, *b*).

Four species of *Argonauta* are known: they all inhabit the

FIG. 33.—Fossil hooklets of Cephalopod. Lithographic Stone: Solenhofen. Wall-case 1.

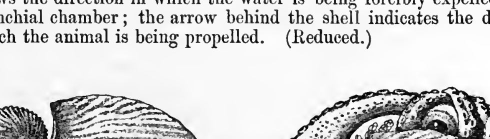



FIG. 34.—Female Argonaut in act of swimming: the arrow near the funnel (*s*) shows the direction in which the water is being forcibly expelled from the branchial chamber; the arrow behind the shell indicates the direction in which the animal is being propelled. (Reduced.)

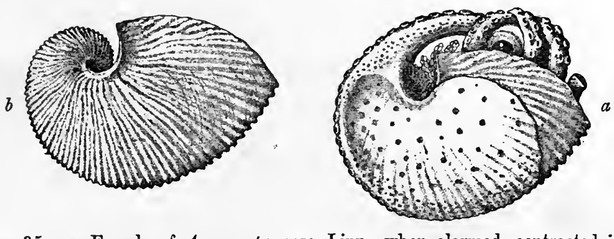



FIG. 35.—*a*, Female of *Argonauta argo*, Linn., when alarmed, contracted into its shell. The expanded dorsal arms still cover more than half the shell. *b*, Shell of *Argonauta* with animal removed. (Reduced.)

**Squids.**
**GALLERY VII.**

open water of the warmer seas, such as the Mediterranean, the Indian, and China seas. One species, *A. hians*, Sol., occurs fossil in the Pliocene beds of Piedmont.

In the Octopodidæ (Fig. 17) the dorsal arms are not expanded as in *Argonauta*, but are more elongated, and united by a web at the base. The shell is quite rudimentary, but is represented by two short stylets enclosed in the mantle. The body is oval, without fins; the skin is warty and richly covered with pigment-cells; the arms, which are of unequal length, are each provided with

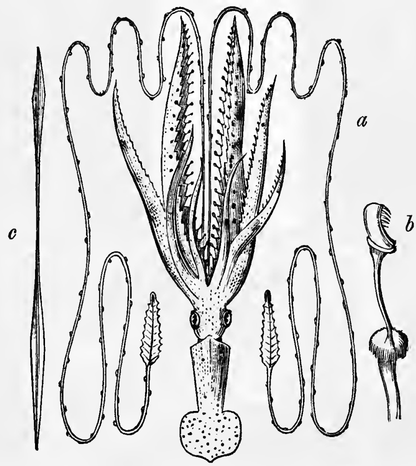



Fig. 36.—*Cheiroteuthis Veranyi*, D'Orb. Atlantic. (Reduced.) *a*, the animal; *b*, a single hooklet, enlarged; *c*, the internal shell or pen.

two rows of suckers (Fig. 21), there being as many as 120 pairs on each arm. The eyes are of moderate size, but the beak is very strong and recurved (Fig. 22).

There are six genera living at the present day: of these *Octopus* is the most cosmopolitan, being found along all the temperate and tropical coasts of the globe. Forty-six living species have been described. A single example occurs fossil in the Cretaceous beds of the Lebanon, named *Palæoctopus* (*Calaïs*) *Newboldi*, which has triangular fins on the sides of its body.

(*b*) Decapoda.—From the eight-armed division of the Dibranchiata we pass to the ten-armed "Squids" and "Calamaries" (called

*Teuthidæ* by Aristotle). This family not only embraces the largest number of genera, but also those of the greatest size—the giants, in fact, of the Molluscan kingdom. They have eight ordinary arms and two long tentacular arms, with expanded, club-shaped extremities, which take their origin within the circle of the eight ordinary arms, and are often six times as long. (Fig. 36.)

**Calamaries.**

**GALLERY VII.**

In the genera *Sepia*, *Sepiola*, and *Rossia* these tentacles are retractile, and can be withdrawn into two suborbicular pouches. In *Loligo* and *Sepioteuthis* they can be partially drawn in; in *Cheiroteuthis* they are non-retractile. These tentacles, which are armed with hooklets or suckers at their extremities, are used, like the lasso of the Indian, to seize their prey when at a distance. The fossil hooklets of several armed calamaries have been met with in the Liassic and Oolitic formations, and many specimens are exhibited. (See Fig. 33.)

Squids and cuttles frequent the sea in numbers, and appear in great shoals at certain seasons (probably for spawning) on the coasts and banks both of Europe and America. They are extremely alert and active in their movements, and, by means of their pigment-cells (called *chromatophores*), they possess the same power as does *Octopus* of changing the colour of their skin to suit the surface of the bottom, or rocks on which they rest.

Squids are taken in large numbers, for bait, by the fishermen on the coast of Cornwall, with nets or lines. They are called pen-and-ink fish, from the shape of their internal shell resembling a quill pen in form, and from the readiness with which (when alarmed) they discharge the inky fluid contained in their ink-bag. These translucent horny "pens" increase in number with age, an old squid having as many as three or four enclosed within its mantle, closely fitting together. The eggs are deposited in slender sheaths, arranged in bunches like a mop, as many as 42,000 eggs being found by computation in one bunch.

One of the smallest known Cephalopods is the *Sepiola Rondeletii*. This and an allied species do not exceed two to four inches in length. The body is very short, and has two small, rounded, lateral fins. (See Fig. 15.)

2.—Tetrabranchiata (four-gilled division). Cephalopods in which the lateral margins of the mid-foot are inflected (but not fused together), so as to form a funnel by apposition. The lobes of

**Nautilus**
**GALLERY VII.**
**Wall-case 1a.**

the fore foot, which surround the mouth, carry numerous sheathed tentacles (not suckers). There are two pairs of comb-like gills, and two pairs of excretory organs. There are two oviducts, right and left, in the female, and two sperm-ducts in the male, the left duct in both being rudimentary. The eyes are hollow chambers opening to the exterior by minute orifices (pin-hole camera) and devoid of refractive structures. There is no ink-sac present in this order. (See Figs. 18, 19, 37, and 38.)

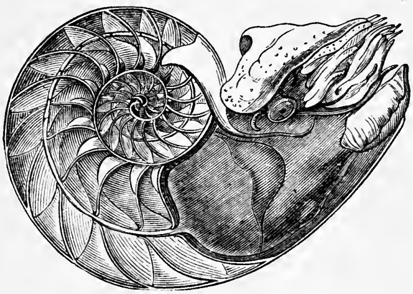


Fig. 37.—Animal and shell of living *Nautilus pompilius*, Linn. (The shell is cut open to show the deserted hinder chambers.)

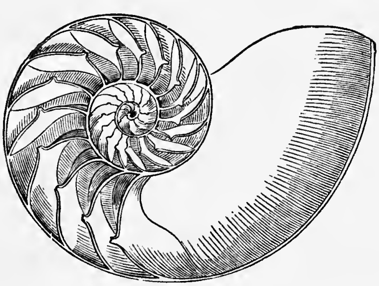
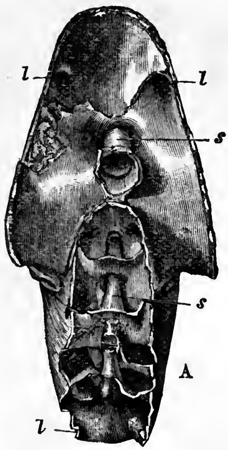


Fig. 38.—Section of shell of *Nautilus* showing septa and empty body-chamber.

A strong and well-developed external shell, either coiled or straight, is present, and is not enclosed in a fold of the mantle (except perhaps in such narrow-mouthed shells as *Gomphoceras*, which was probably enclosed in the mantle, as is that of *Spirula* amongst the Dibranchiata). The shell consists of a series of

chambers, the last-formed of which is occupied by the body of the animal, the hinder ones successively deserted, being found, whilst the animal is alive, to contain gas. A tube, or *siphuncle*, passes from the body-chamber through each septum of the shell. This siphuncle, which in the recent *Nautilus* is attached to the animal's body, is a membranous tube, with a very thin pearly covering.

**Aturia.**
**GALLERY VII.**
**Wall-case 1a, Table-case 59.**



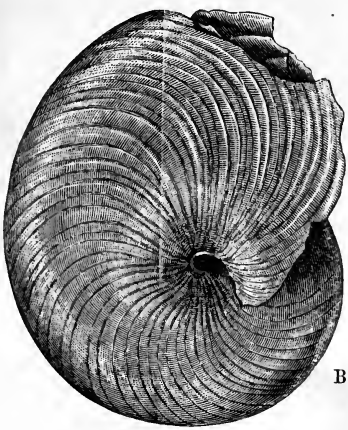




Fig. 39.—*Aturia aturi*, Bast., from the Miocene (or Oligocene) of Dax, Bordeaux.

A, front view of a specimen partly broken open, showing *l*, *l*, *l*, orifices of the lateral lobes of the septa; *s*, *s*, siphuncle. (Reduced $\frac{2}{3}$ nat. size.)

B, side-view of *A. aturi* var. *Australis*, M'Coy, from the Miocene of Victoria, Australia, showing the closed umbilicus and the fine lines of growth. (Nat. size.)

In the extinct genus *Aturia* the siphuncle is composed of a succession of funnel-shaped tubes, each inserted into the preceding one (Fig. 39). In others (Fig. 40) the siphuncle is beaded, while in the oldest genera (*Actinoceras*, *Gyroceras*, and *Phragmoceras*) the siphuncle is large, and contains in its centre a smaller tube with radiating plates between, like the lamellæ of a coral (Fig. 43).

In some instances the siphuncle is preserved and the shell destroyed, giving the appearance of a string of beads (*Actinoceras*); or of a series of vertebræ of some higher animal (*Huronia*, Fig. 44). Siphuncles of *Huronia* six feet in length and one and a half inches

**Nautilus. GALLERY VII. Wall-cases 7 & 8.**

in diameter were seen by Dr. Bigsby standing out in bold relief from the cliffs of Silurian rock on Drummond Island, Lake Huron, North America, only faint traces of the chambers, in one or two instances, being visible.

In *Orthoceras* there is evidence of a continued connection through these large and complex siphonal tubes with the whole series of body-chambers; but if this were the case in the Silurian Cephalopoda, it is not so in *Nautilus*, there being no connection whatever between the siphuncle and the disused and deserted chambers of the shell, which are hermetically sealed up. They are the left-off portions of the cephalopod's habitation, just as much as the lower part of the skeleton of a coral is shut off from the upper part inhabited by the living zoophyte. In *Euomphalus*, a Silurian gasteropod, portions of the whorls of the shell, not needed by the animal, are similarly closed by a shelly septum or division.

The modern *Nautilus* is rather a sluggish animal, living mostly at the bottom in deep water, where it may perhaps crawl by means

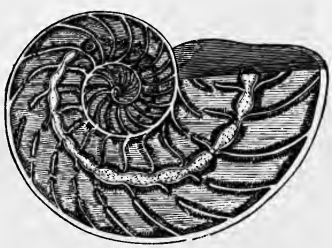


Fig. 40.—Section of *Nautilus striatus*, Sby., to show the septa and the siphuncle. Lias: Charmouth, Dorset. (Much reduced.)

of its tentacles, mouth downwards, feeding upon small crabs and Echinoids. The fishermen of Fiji, the New Hebrides, etc., catch it in their crab-pots, which it enters. Wiley says that it habitually swims backwards, after the manner of other Cephalopods, by discharging the water from its funnel.

This Tetrabranch, or four-gilled division, represented to-day by a single living form, the "pearly Nautilus," was formerly most abundant almost all over the globe, shells referred to it being found in rocks of all ages from the Silurian to the newer Tertiary deposits. The extinct genera were extremely varied in form, but nearly all possessed shells of the same compact nature as their

modern representative, and most, if not all, of them agreed with it in being external.

**Nautilus.**

**GALLERY VII.**

**Table-case 71.**

Modifications of the *Nautilus* type of shell are not unfrequent, and they have given rise to several well-marked groups or genera. Thus, in *Barrandeoceras* the whorls are few, flattened, and very slightly embracing; in *Gyroceras* they are numerous, elliptical or subtriangular in section, and very loosely coiled; in *Discites* they are also numerous, compressed, and more or less sulcated on the periphery; the umbilicus is wide, and has a central perforation. In some genera, as *Ephippioceras* in the Carboniferous, and *Aturia* in the Eocene and Miocene, the sutures mark the chief differential characters.

The septa in the genus *Nautilus* are generally simple or gently flexuous, but in *Aturia* they have a deep narrow V-shaped lobe

FIG. 41.—*Aturia ziczac*, Sby., showing the elegant curved lines which mark the septa of the shell. London Clay: Highgate. (Nat. size.)

on each side. Some of the Cretaceous and Oolitic species of *Nautilus* also have very flexuous suture-lines.

(*a*) NAUTILOIDEA.—The fossil forms belonging to this suborder represented in the collection are as follows:—

| No. of Species. | | |
|---|---|---|
| 12. | *Trocholites*, Ordovician. | T.-c. 71 |
| 13. | *Gyroceras*, Silurian, Devonian, Carboniferous. | ,, 71<br>W.-c. 7 |
| 2. | *Hercoceras*, Devonian. | T.-c. 71 |
| 6. | *Barrandeoceras*, Ordovician to Silurian and Devonian. | ,, 71 |
| 10. | *Discites*, Carboniferous. | ,, 71 |
| 3. | *Ephippioceras*, Carboniferous. | ,, 71 |
| 14. | *Cœlonautilus*, Carboniferous. | ,, 71 |
| 5. | *Pleuronautilus*, Devonian, Carboniferous, Triassic. | ,, 71 |
| 13. | *Temnocheilus*, Devonian to Carboniferous and Trias. | ,, 71 |
| 9. | *Solenocheilus*, Carboniferous. | ,, 71 |
| 107. | *Nautilus*, Trias to Recent. | T.-c. 59, W.-c. 2 & 13 |
| 6. | *Aturia*, Eocene to Miocene. | ,, 59, ,, 2 |

**Reference to Wall- or Table-case**

**Orthoceras**
**GALLERY VII.**
**Wall-case 8.**

Although the fossil representatives of this section of the Cephalopoda (Nautiloidea) are very numerous and varied in form, they always have simple suture-lines. The simplest form (*Orthoceras*) is like a Nautilus unrolled; it has a straight, or only slightly bent, more or less conical tube, ornamented sometimes with longitudinal, sometimes with transverse ridges, or merely with transverse striæ, and divided into chambers by transverse partitions. The last chamber is relatively large and contained the animal; a tube (the siphuncle) extended from the hinder portion of the animal through each partition to the first chamber of the shell, just as in the recent *Nautilus*. These animals probably crawled along the sea-bottom like the living *Nautilus*, carrying their shells in a nearly vertical position. This genus, some species of which were several feet in length, ranges from the Cambrian to the Trias, being especially abundant in the Silurian rocks, a very large number having been described from the Silurian rocks of Bohemia. Numerous examples of these straight septate shells may be seen in Wall-case 8, among them being several excellent examples of an *Orthoceras* from China (*Orthoceras Chinense*), there known as "Pagoda stones" from the popular belief that they are formed underground where the shadow of a pagoda has fallen upon the surface. Some of these are sectioned and polished, and show the central tube or siphuncle perforating all the chambers. A large example of the same species may be seen fixed up at the end of the same wall-case.

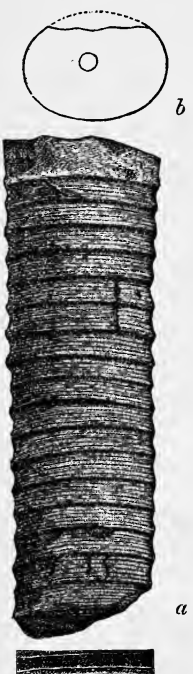


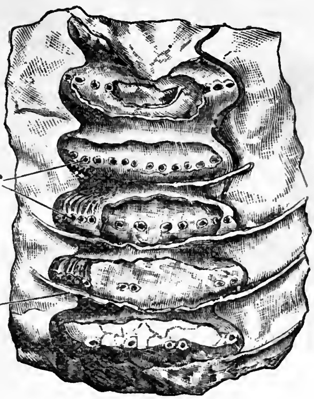

FIG. 42.—*Orthoceras ornatum*, Boll. *a*, example with some of the test adherent; *b*, section with siphuncle; *c*, portion of test enlarged. U. Silurian: Gothland.

On the wall between this wall-case and the doorway is a fine polished slab from Bohemia, exhibiting numerous examples of these straight-shelled forms.

**Actinoceras.** **GALLERY VII.** **Wall-cases 7 & 8.**

Among other straight shells may be mentioned *Endoceras*, *Actinoceras*, and *Huronia*. The differences between the two former and *Orthoceras* are illustrated by the fine series of specimens in the glass case mounted on the wall on the left-hand side of the doorway.

43*a*.




43*b*.

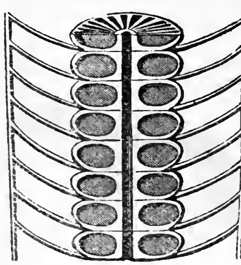


FIG. 43*a*.—Fragment of weathered specimen of *Actinoceras Bigsbyi*, Bronn, showing the foramina (*f*) in the walls of the siphuncle, by which the tubuli thrown out by the endosiphon may have communicated with the septal chambers; (*s*) the septa. (Nat. size.) From the Cincinnati Group (Ordovician): Versailles, Kentucky, U.S.

FIG. 43*b*.—Ideal section (restored) of *Actinoceras*, showing beaded siphuncle and septa.

In *Orthoceras* the siphuncle is narrow, cylindrical, and usually central or nearly so; in *Actinoceras* the portions of the siphuncle between the septa are inflated and bead-like; while in *Endoceras* the siphuncle is relatively very large and marginal. Some of the shells of *Actinoceras* must have been immense, probably exceeding eight feet in length, for in Wall-case 7 may be seen the body-chamber of *Actinoceras giganteum*, which has a diameter of about 11 inches; and a huge fragment, the whole of which appears to be septate, measures 2 ft. 5 in. in length, the diameter of the larger end being about 8 inches, that of the smaller about $4\frac{1}{2}$ inches. This genus, which possibly occurs in the Cambrian, ranges through the Ordovician, Silurian, and Devonian to the Carboniferous.

*Huronia* resembles *Actinoceras*, but the portions of the siphuncle between the septa are more inflated in their anterior than in their

**Huronia.** posterior part. This genus, so far as at present known, is limited **GALLERY VII.** **Wall-case 8.** to the Silurian rocks of North America.

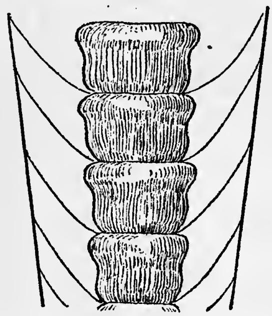


Fig. 44.—*Huronia vertebralis*, Stokes. Niagara Group (Wenlock): Drummond Island, Lake Huron. From specimen presented by Dr. Bigsby. The septa are added from Dr. Bigsby's drawing; they were only indicated in the specimen by "colourless lines on the brown limestone." (Much reduced, after a drawing by Dr. S. P. Woodward.)

**Wall-case 8.** In the genus *Piloceras* the shell is conical and comparatively short, and the siphuncle very large; usually only the latter is

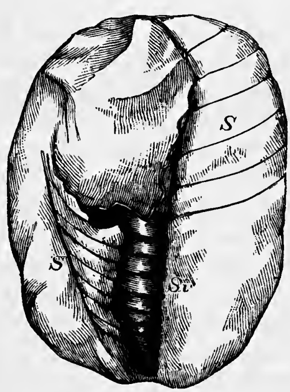



Fig. 45.—*Piloceras invaginatum*, Salter. Durness Limestone: Sutherlandshire. *S*, *S*, remains of septa; *Si*, siphuncle, a little restored in the lower part, with ridges marking the attachment of the septa. (One-half natural size.)

preserved. It is found in North America, and in the British Islands only in the Durness Limestone in Sutherlandshire.

*Gomphoceras* is sometimes ovoid and nearly straight, sometimes feebly curved; its aperture is very much constricted and more or less T-shaped, and its siphuncle a little inflated between the septa. This genus, according to our present knowledge of it, is restricted to the Silurian epoch, numerous examples of both forms of the genus occurring in the Silurian rocks of Shropshire and Worcestershire.

**Gomphoceras. GALLERY VII Wall-case 7**

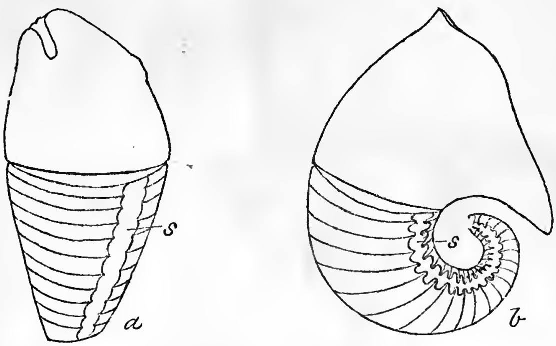



FIG. 46. — *Gomphoceras*. Silurian: Shropshire. *a*, nearly straight form (= *Gomphoceras* as formerly restricted). *b*, curved form (= *Phragmoceras* as formerly restricted). *s*, *s*, the siphuncle.

*Ascoceras* is a small and somewhat aberrant form. It consists of two portions, the first, or older, resembling that of an *Orthoceras*, having a cylindrical shell, with deep chambers, and a slender, tubular siphuncle, and this stage being succeeded by a second or *Ascoceras*-stage, after the completion of which the older or *Orthoceras* portion was cast off; hence its rare preservation. In the *Ascoceras*-stage the shell is sac-like; the septa are fairly regular and close together on one side of the shell, but sweep upwards towards the aperture in a sigmoid curve before they are attached to the other side of the shell. The aperture is simple and open, as in *Orthoceras*; but in a closely allied form, *Glossoceras*, the aperture is partly closed by lobes extending from its margin. *Ascoceras* occurs in the Ordovician of North America and the Silurian of Europe, by far the greater proportion of the species coming from Bohemia. (See Fig. 47.)

**Ascoceras. Wall-case 7.**

*Poterioceras* ranges from the Ordovician to the Carboniferous. It is a pear-shaped shell, the smaller part being chambered and

**Ascoceras.** **GALLERY VII.** **Wall-case 7.**

perforated by a siphuncle which is somewhat inflated between the septa; the upper and larger portion contained the animal. The whole shell is usually slightly curved, its aperture being simple. Very fine examples of this genus may be seen in

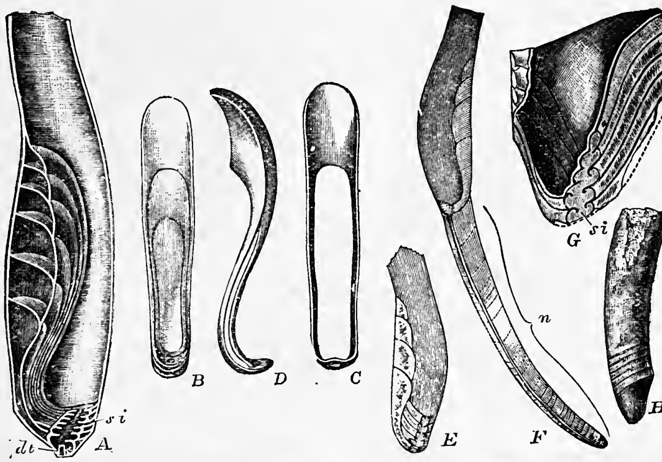



**Table-case 57.**

Fig. 47.—A. Schematic view of the interior of *Ascoceras manubrium*, Lindstr., Upper Ludlow (U. Silurian), I. of Gothland, showing the structure and arrangement of the septa: *si*, siphuncle; *dt*, duct that communicates with the siphuncle of the Nautiloid portion of the shell (*n*, fig. F). B. Schematic view of three sigmoid septa of *Ascoceras fistula*, Lindstr., seen from the ventral side. C. View of the third septum of the same species, shown as free, as if detached from the shell, to exhibit the large central lacuna. D. The same, viewed laterally (the siphuncular orifice is seen at the bottom of all these figures). E. Longitudinal section of a specimen of *Asc. decipiens*, Lindstr., from Sandarfve kulle (hill), with four regular septa above the sigmoid ones. F. Schematic view of *Asc. decipiens*, represented as if complete; *n*, the Nautiloid portion of the shell. G. Longitudinal and median section of the posterior part of the shell of *Choanoceras mutabile*, Lindstr., showing the interior, with the outlines of the incomplete septa; *si*, siphuncle. H. Exterior of the same specimen, reduced to about one-third natural size.

A model of *Ascoceras* (executed by Mr. G. C. Crick, F.G.S.) is placed in Table-case 57 at entrance to the Cephalopod Gallery (Gallery VII).

Wall-case 7, from the Carboniferous Limestone of Ireland. It must have attained considerable dimensions, for an example of *Poterioceras cordiforme* from the Red Sandstone of Closeburn, Dumfriesshire, is nine inches long and seven and a half inches in its greatest diameter.

Among these nearly straight forms may also be mentioned the usually short, conical, slightly curved members of the genus *Cyrtoceras* (Fig. 48), which ranges from the Cambrian to the Carboniferous, the greater number of forms being found in the Silurian. **Cyrtoceras.** **GALLERY VII. Wall-case 7.**

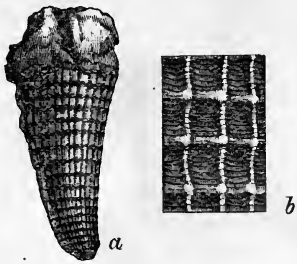
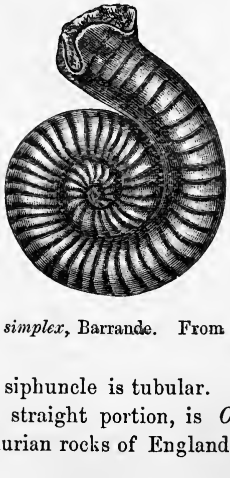


Fig. 48.—*Cyrtoceras* (*Meloceras*) *clathratum*, Foord. Silurian: Feuguerolles (Calvados), France. *a*, part of shell, natural size; *b*, portion of surface, magnified.

Passing to the forms which are more or less discoidal, we have *Lituites*, a genus occurring in the Ordovician rocks of North Germany and Sweden, in which the shell is at first coiled in one plane, and then extended in a long straight piece until the aperture is reached, the latter being contracted by lobes extending **Table-case 71.**



**Ophidioceras.**

Fig. 49.—*Ophidioceras simplex*, Barrande. From the Silurian of Bohemia.

from its margin. Its siphuncle is tubular. Allied to *Lituites*, but lacking the elongated straight portion, is *Ophidioceras* (Fig. 49), known only in the Silurian rocks of England and Bohemia.

**Trochoceras.** **GALLERY VII.** **Table-case 71.**

In *Trochoceras* the shell is not coiled in one plane, but is helicoidal. It ranges from the Cambrian to the Devonian, but attains its greatest development in the Silurian formation, the rocks of this age in Bohemia, England, and the United States containing abundant species. The Ordovician genus *Trocholites* consists of three or four involute whorls, and is coiled in one plane; it has been found in North America, Europe, and possibly also in India.

**Wall-case 7, Table-case 71.**

*Gyroceras* is coiled in one plane, but the whorls only just touch each other, or are completely out of contact. It ranges from the Silurian to the Carboniferous. Some of the Devonian forms from Germany and South Devon are ornamented with regularly-arranged, strong, tubercular folds; while some of the Carboniferous forms possessed numerous longitudinal ridges, studded with small tubercles.

The discoidal, somewhat evolute shell *Hercoceras* (Fig. 50), is at present known only from the Devonian rocks of Bohemia; the aperture of the shell is partially closed by the infolding of its inner portion; its whorls are ornamented with a row of spines or strong tubercles arranged longitudinally.

Fig. 50.—*Hercoceras mirum*, Barrande. (After Barrande.) Devonian: Bohemia.

**Table-case 71.**

*Barrandeoceras* is a discoidal, involute shell ranging from the Ordovician to the Silurian; in England it is found in the Silurian rocks of Shropshire and Worcestershire.

*Discites*, with its compressed, evolute whorls (Fig. 51), is limited to the Carboniferous rocks; numerous examples of the genus have

been found in Great Britain and Belgium. There is usually a large vacuity in the centre of the shell, the innermost portion of the shell being sometimes out of contact with the adjacent whorl; **Nautilidæ. GALLERY VII. Table-case 71.**

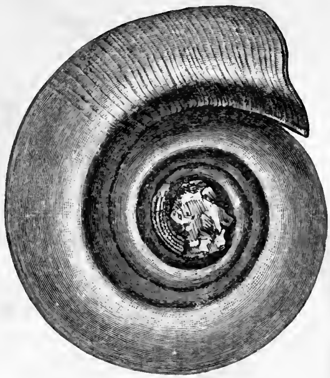


FIG. 51.—*Discites mutabilis*, M'Coy. Carboniferous Limestone: Ireland.

the inner whorls are often richly ornamented, the older whorls having usually merely transverse lines of growth. Some species

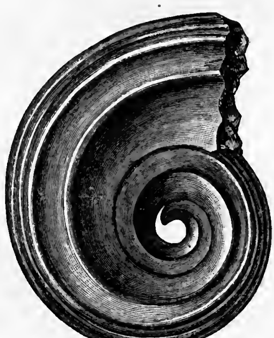


FIG. 52.—*Cœlonautilus multicarinatus*, Sby. Carboniferous Limestone: Ireland.

have also spiral sulci, but these spiral ornaments are much more prominent in *Cœlonautilus* (Fig. 52), which ranges from the Carboniferous to the Trias.

**Nautilidæ.** **GALLERY VII.** **Table-case 71.**

*Pleuronautilus* has strong transverse costæ; it occurs in the Devonian, and extends into the Trias. *Temnocheilus*, ranging from the Devonian to the Carboniferous, has a broad periphery and the prominent lateral portion of the whorl usually angular, and sometimes ornamented with obtuse tubercles.

In the Carboniferous genus *Solenocheilus* (Fig. 53), the shell generally has the form and surface characters of *Nautilus* proper, the siphuncle is near the periphery, and the lip on each side is drawn out into a narrow spout-like projection.

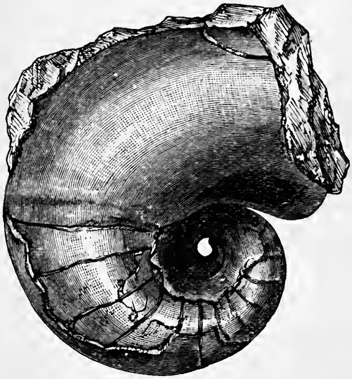


Fig. 53.—*Solenocheilus conspicuum*, De Koninck. Carboniferous Limestone: Ireland. (Reduced.)

**Table-case 59, Wall-cases 2 & 13.**

Commencing in the Trias, the genus *Nautilus* is numerously represented in the Jurassic, Cretaceous, and Tertiary rocks, and about two species are found living at the present day.

**Table-case 70.**

(*b*) Ammonoidea.—Turning from the Nautiloidea to the Ammonoidea, we have such forms as *Bactrites*, *Clymenia*, and the large group of the Goniatites. In *Bactrites* the shell is small and straight, the siphuncle marginal, and the sutures simple like those of *Orthoceras*. In *Clymenia* the shell is coiled into a flat spiral, the whorls of which are in contact, the siphuncle is large and on the inner side of the shell, and the suture-line is simply folded or lobed. Both genera are found in the Devonian, the former also occurs in the Silurian.

Goniatites

GALLERY VII. Table-case 70.

The numerous group of the Goniatites is now very much subdivided. Its members differ very considerably from each other. Some are nearly flat (*Beloceras*), while others are nearly globular

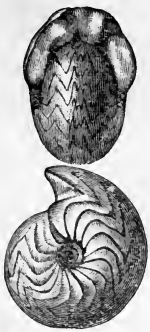


FIG. 54.—Goniatite (*Glyphioceras sphæricus*, Martin). Carboniferous Limestone: Derbyshire.

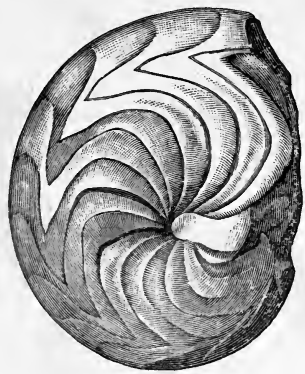


FIG. 55.—Goniatite (*Brancoceras Ixion*, Hall). Goniatite Limestone (Kinderhook Group): Rockford, Indiana.

FIG. 56.—Goniatite (*Prolecanites compressus*, Sby.). Carboniferous Limestone: Isle of Man. (Reduced.)

(some forms of *Glyphioceras*). Sometimes the umbilicus is wide, while the inner whorls are more or less exposed; sometimes it is

**GALLERY VII.**
**Table-case 70.**

narrow, and the inner whorls are more or less completely concealed by the outer whorl. They are usually smooth or with only fine lines of growth, rarely with tubercles or ribs. The suture-line may be simply waved (*Agoniatites*) or angulated (*Brancoceras*) (Fig. 55), or still more complicated (*Beloceras, Prolecanites*) (Fig. 56), but it is never foliated and incised as in the Ammonites. The siphuncle is always small and close to the periphery of the shell. Numerous forms of Goniatites are found in the Devonian and Carboniferous, and they also occur in the Permo-Carboniferous rocks of the Salt Range, India.

The great group of the Ammonites (using that term in its general acceptation) is distinguished from all other kinds of chambered shells of the Cephalopod type by the complicated foliations of the margins (*sutures*) of the partition walls or *septa* by which such shells are subdivided. Though typically coiled, much in the manner of the flat pond-snail, *Planorbis*, there are straight and variously curved Ammonites; but all have the common character of a highly foliated "suture-line."

The derivation of the Ammonites from the Goniatites has been clearly made out in certain groups by means of this suture-line, the development of which from its earliest stages of growth has furnished the key in such investigations.

The following sixteen families or sections of the Ammonites are the result of recent researches in this large and difficult group of fossils: (1) Arcestidæ; (2) Tropitidæ; (3) Ceratitidæ; (4) Cladiscitidæ; (5) Pinacoceratidæ; (6) Phylloceratidæ; (7) Lytoceratidæ; (8) Ptychitidæ; (9) Amaltheidæ; (10) Arietidæ; (11) Ægoceratidæ; (12) Polymorphidæ; (13) Harpoceratidæ; (14) Pulchellidæ; (15) Haploceratidæ; (16) Stephanoceratidæ.

These sections will be found amply represented in the Gallery of Cephalopoda, No. VII.

Omitting certain forms of doubtful relationship, to be subsequently dealt with, a brief account of the above groups may here be given. The first four families are found chiefly in the Permian rocks of Sicily and of India, and in the Triassic rocks of the Alps (Alpine Trias). Among the Arcestidæ may be noticed the singular Triassic genus *Arcestes*, with its deeply embracing whorls and contracted aperture; and among the Tropitidæ the characteristic genus *Tropites*. In the Ceratitidæ the well-known

**Table-case 69.**

Muschelkalk species, *Ceratites nodosus*, with its peculiar suture-line (Fig. 57), and the richly ornamented shell of *Trachyceras Aon* (Fig. 58), are met with. In the CLADISCITIDÆ may be mentioned the genus *Cladiscites*, often ornamented with closely-set spiral ridges. **GALLERY VII. Table-case 69.**

FIG. 57.—*Ceratites nodosus*, De Haan. Muschelkalk.

Three very peculiar shells also deserve notice. They are *Choristoceras*, *Cochloceras*, and *Rhabdoceras*. In *Choristoceras*, the last whorl becomes separated from the preceding ones, in the manner of *Crioceras*. *Cochloceras* is turreted like a Gasteropod,

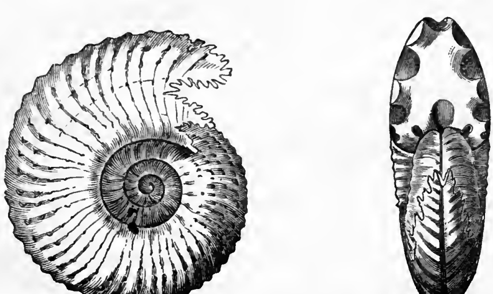


FIG. 58.—*Trachyceras Aon*, Münst. Alpine Trias.

and may be compared with *Turrilites* in this respect. *Rhabdoceras* is straight, like *Baculites*. All are from the Alpine Trias.

The PINACOCERATIDÆ contain the large species known as *Pinacoceras Metternichi*, from the Keuper of Hallstadt, in Upper Austria. **Wall-case 12.**

**GALLERY VII. Wall-case 11.** The extreme delicacy of the ramifications of the sutures in this species excels that of any other Ammonite known. The leaf-like terminations of the sutures in the PHYLLOCERATIDÆ are the distinguishing feature in this group; they are well seen in the typical species, *Phylloceras heterophyllum*, Fig. 59. This family began in the Trias, but it extended through the Jurassic into the Cretaceous. A large example from the Chalk near Brighton may be seen between Wall-cases 3 and 4, measuring 44 inches in diameter.

The suture-line is again the most important feature in the family next in order, viz. the LYTOCERATIDÆ, for it supplies the justification for connecting together an assemblage of genera

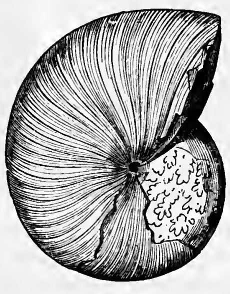


FIG. 59.—*Phylloceras heterophyllum*, Sby. Upper Lias: Whitby.

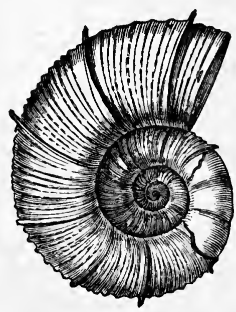


FIG. 60.—*Lytoceras fimbriatum*, Sby. Middle Lias: Charmouth.

differing widely in external shape. The family begins in the Trias, and is largely represented in the Jurassic and Cretaceous rocks. One of the most beautiful species of this group is *Lytoceras fimbriatum* (Fig. 60), whose regular, wavy lines running across **Wall-case 11.** the shell make it very attractive to the eye; the effect being heightened by the bold, sharp, transverse ridges encircling the shell **Wall-case 3, Table-case 61.** at frequent intervals, representing the former "lips" of the shell. In *Macroscaphites* the shell is for about four convolutions or whorls exactly similar in shape to a *Lytoceras*, when it suddenly takes a direction tangential to the coiled part, and after pursuing a nearly straight course for a short distance it bends back in a hook-like termination (Fig. 61). In *Hamites* the shell is bent at both ends, the apical or smaller (initial) end being again bent: thus the shell has three curvatures. Owing to its slenderness the apical part

of the shell is rarely obtained (Fig. 62). *Hamites* attains its greatest development in the Gault. In *Hamulina* and *Ptychoceras* (Neocomian and Gault) there is but one sharp bend in the shell, the straight limbs in *Ptychoceras* being actually in contact at, and in the region of, the aperture. **GALLERY VII. Table-case 60, Wall-case 3.**

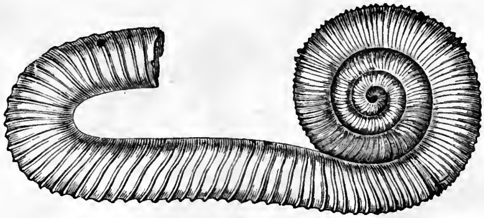


FIG. 61.—*Macroscaphites Ivanii*, D'Orb. Lower Cretaceous.

A still further departure from the typical form of the Cephalopod shell is encountered in the singular genus *Turrilites*, which takes the form of a Gasteropod shell (Fig. 63). The mouth or aperture is, however, turned towards the left-hand side, or, in other words, the shell is "sinistral." *Turrilites* is found exclusively in Cretaceous rocks. *Helicoceras* is coiled like *Turrilites*, but the whorls are disconnected. In *Heteroceras* the last whorl is detached **Wall-case 3, Table-case 60.**

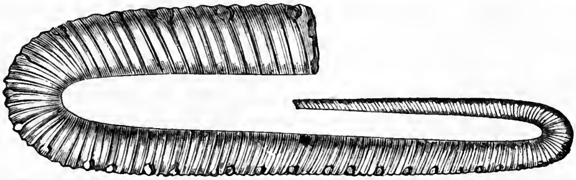


FIG. 62.—*Hamites elegans*, D'Orb. Gault: Folkestone.

(Fig. 64). Both are Cretaceous genera. In *Baculites* (Cretaceous) the shell is perfectly straight, except in the earliest or embryonic stage of its development, in which it is coiled. It occurs in vast numbers in the Danian (Upper Continental Chalk) of the North of France, whence the name *Baculite* Limestone has been given to those beds (Fig. 65). **Table-case 57.**

The next group, PTYCHITIDÆ, consists for the most part of Triassic genera, but its earliest representatives come from the **Wall-case 3, Table-case 69.**

GALLERY VII. Table-case 69.

Permian rocks of Sicily. *Ptychites* and *Gymnites*, from the Alpine Trias, are among the best-known genera. *Daraelites* of the Permian of Sicily is specially interesting from the fact that its sutural characters resemble those of some of the Goniatites; and taking the PTYCHITIDÆ as a whole it is considered that they present a gradational series connecting the Goniatites with the Ammonites.

FIG. 63.—*Turrilites catenatus*, D'Orb. Gault: Folkestone.

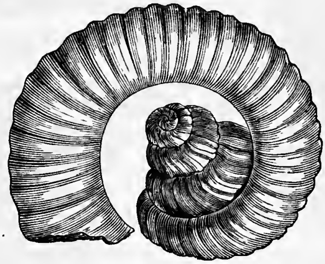


FIG. 64.—*Heteroceras Emerici*, D'Orb. Cretaceous.

Table-cases 62-68, Wall-cases 4, 5, 9-11.

The principal feature observable in the AMALTHEIDÆ is the *keel* or projecting edge of the outer border (periphery) of the shell, which is prolonged beyond the margin of the aperture in the form of a long narrow process. In *Amaltheus margaritatus* (Middle Lias) the keel is prominent and beautifully sculptured, resembling

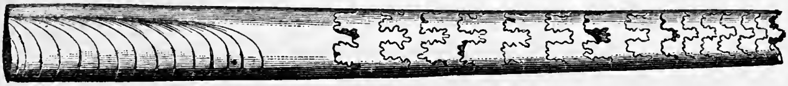


FIG. 65.—*Baculites anceps*, Lamk. Upper Cretaceous.

the strands of a miniature rope. *Cardioceras cordatum* (Oxford Clay) is one of the most highly ornamented of Ammonites, having a series of numerous sharp ribs upon the sides of the shell, which, in passing over the periphery, form a series of fine crenulations (Fig. 66). *Schlœnbachia varians* (Lower Chalk) has strong and knotted ribs.

The family of the ARIETIDÆ embraces a large number of Ammonites which at first sight appear to be only remotely related; nevertheless, a careful study of their development has led to their **GALLERY VII. Wall-cases 5, 9, 11; Table-cases 62-9.**

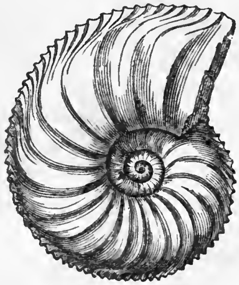


FIG. 66—*Cardioceras cordatum*, Sby. Oxford Clay.

being grouped together. Among the most familiar members of this large group are the following, viz.: *Psiloceras planorbis*, which gives its name to the "zone of *Ammonites planorbis*" of the Lower Lias, and at the same time marks the first occurrence of Ammonites in British rocks; *Arietites Bucklandi* (*A. Bucklandi* zone); *Arietites obtusus*, Fig. 67 (*A. obtusus* zone); and *Oxynoticeras oxynotum* (*A. oxynotus* zone).

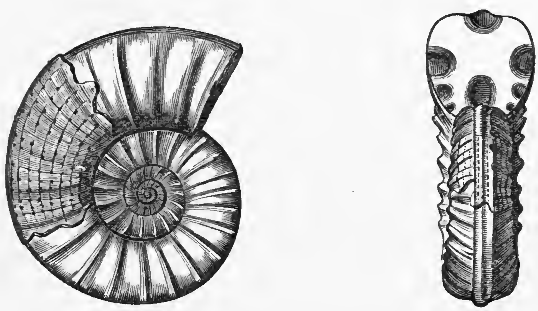


FIG. 67.—*Arietites obtusus*, Sby. Lower Lias.

The shells in this group are flattened in form, and the whorls usually only slightly embracing, and generally numerous (see *Psiloceras planorbis*, e.g.). *Oxynoticeras oxynotum* is remarkable

GALLERY VII.

for the extremely attenuated and trenchant form of the adult shell. In this species the whorls are deeply embracing, so that very little is seen of the inner volutions.

Table-case 68, Wall-case 12.

The ÆGOCERATIDÆ are restricted to one genus, *Ægoceras*, of the Lias. *Ægoceras capricornus*, Fig. 68 (*A. capricornus* zone of the Lower Lias), *Æ. Davæi* (Fig. 69), and *Æ. armatum* of the Lower Lias, are some of the most characteristic species. The last-named species is conspicuous for the long spiny processes projecting from the sides of the shell.

Wall-case 12.

The family POLYMORPHIDÆ has been constituted to contain certain genera which have been separated from the ÆGOCERATIDÆ

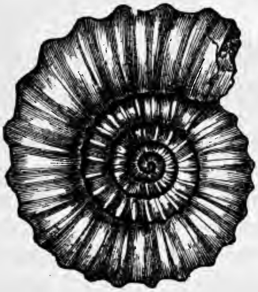


FIG. 68.—*Ægoceras capricornus*, Schloth. Lower Lias.

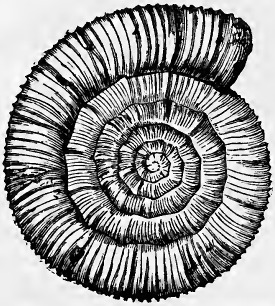


FIG. 69.—*Ægoceras Davæi*, Sby. Lower Lias.

on the one hand and from HARPOCERATIDÆ on the other. It is notable for the variations undergone by the shell in passing from the young to the adult stage of growth. *Liparoceras Bechei* (Middle Lias) is a well-known species with a highly ornate shell. *Hammatoceras Sowerbyi* (Lower Oolite) has a keeled margin in the young shell which it loses in the adult, while the umbilicus, at first narrow, becomes ultimately wide.

Wall-cases 10 & 11.

The HARPOCERATIDÆ are derived from the ARIETIDÆ. The oldest forms begin in the Middle Lias, and they extend into the Inferior Oolite. The shells are flattened and keeled, and have falciform or sickle-shaped ribs, or striæ. *Hildoceras bifrons*, from the Upper Lias of Whitby, shows this kind of ornamentation very distinctly. *Leioceras opalinum* (Upper Lias) is another characteristic species, the aperture with ear-shaped lateral processes. *Grammoceras serpentinum* (Fig. 70) characterizes the

"*serpentinus* zone," or Jet Rock, which has yielded some of the finest and best preserved Ammonites of the Yorkshire Lias. Of Inferior Oolite species, *Ludwigia Murchisonæ* and *Oppelia subradiata* may be mentioned. **GALLERY VII. Wall-case 10.**

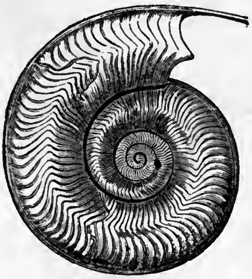


FIG. 70.—*Grammoceras serpentinum*, Schloth. Upper Lias.

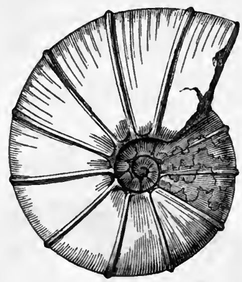


FIG. 71.—*Desmoceras ligatum*, D'Orb. Neocomian.

The PULCHELLIDÆ (Cretaceous) are remarkable for the simplicity of their suture-line, some resembling Goniatites, others Ceratites, in this respect. They are considered to be true Ammonites, descendants of the Jurassic HARPOCERATIDÆ, but in a state of

FIG. 72.—*Stephanoceras Blagdeni*, Sby. Inferior Oolite.

degeneracy. *Pulchellia compressissima* (Lower Cretaceous) and *Neolobites Vibrayeanus* (Upper Cretaceous) may be cited as examples of this small group. **Table-cases 63 & 64.**

The HAPLOCERATIDÆ, ranging from the Inferior Oolite to the Middle Chalk, differ in many respects from the HARPOCERATIDÆ, from which they branch off. The shell is generally thick,

**GALLERY VII.** sometimes remarkably so, as in *Pachydiscus peramplus* of the Middle Chalk; there are also periodic constrictions or grooves upon the surface, which gave rise to the old group-name *Ligati*. Finally, the contour of the edge or periphery of the shell is uninterrupted, there being no keel such as is met with in the HARPOCERATIDÆ. There is an aptychus in a few forms. Of the flatter kinds of shells of the present family, *Desmoceras ligatum* (Fig. 71) of the

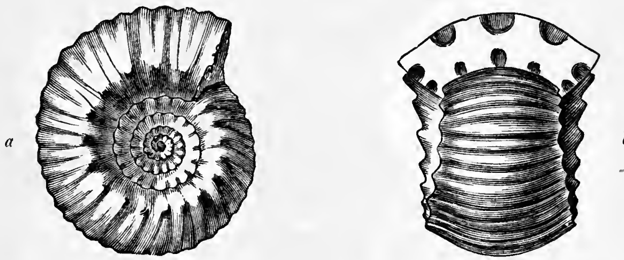



FIG. 73.—*Stephanoceras coronatum*, D'Orb. Callovian. *a*, side-view; *b*, keel view of shell.

**Table-case 64.** Neocomian and *Desmoceras planulatum* of the Gault, may be referred to as examples.

The last section to be described is that of the STEPHANOCERATIDÆ,

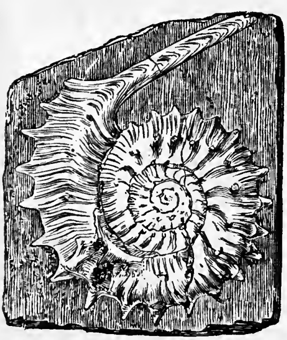


FIG. 74.—*Cosmoceras Jason*, Rein. Callovian, or Oxford Clay.

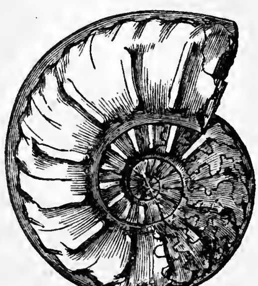


FIG. 75.—*Hoplites radiatus*, Brug. Neocomian.

an extensive and varied group of shells which are characterized in many cases by the symmetrical and beautiful ribbing with

which they are ornamented. A few examples will serve as illustrations, viz.: *Stephanoceras Blagdeni* (Fig. 72), Inferior Oolite, *Stephanoceras coronatum* (Fig. 73) and *Cosmoceras Jason* (Fig. 74), of the Callovian or Oxford Clay, and *Hoplites radiatus* (Fig. 75), of the Neocomian. Another characteristic shell of this group is the *Acanthoceras Rhotomagense* of the Lower Chalk.

**GALLERY VII. Wall-cases 5, 9, 10; Table-cases 62–8; Table-case 62.**

A small group of forms still remains to be considered whose structure (external and internal) has led to their being regarded as offshoots from the STEPHANOCERATIDÆ. They may be divided into two sections—the first consisting of shells partly uncoiled; the second, in which the shells are completely coiled, with deeply embracing whorls.

Section I.—The form of *Scaphites* (Fig. 76) immediately recalls that of *Macroscaphites*, but it differs in several particulars: it is

FIG. 76.—*Scaphites Hugardianus*, D'Orb. Cretaceous.

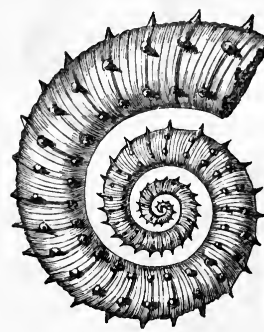


FIG. 77.—*Crioceras Emerici*, Léveillé. Neocomian.

much more closely coiled, that is, the inner coils of the shell are not seen, being covered up by the succeeding ones; and further, the uncoiled part is much shorter and its outline more rounded, while it bends over so as to almost reach the coiled part. *Scaphites* is abundant in the Middle and Upper Cretaceous. *Crioceras* has the form and curvature of an Ammonite, but the whorls are not in contact (Fig. 77). It was formerly supposed that this genus was wrongly founded upon broken shells of *Ancyloceras* (*q.v.*); but the discovery of the aperture has dispelled this error. There is no doubt, however, that *Toxoceras* is nothing more than a fragment of *Crioceras*. *Ancyloceras* begins

**Table-case 61.**

GALLERY VII.

like *Crioceras*, but at the last whorl the shell is straightened out at a tangent to the coiled part, and after attaining a considerable length in a straight course it bends over abruptly in the direction of the coiled part, as in *Scaphites*. *Crioceras* and *Ancyloceras* are variously and elegantly ornamented with ribbing,

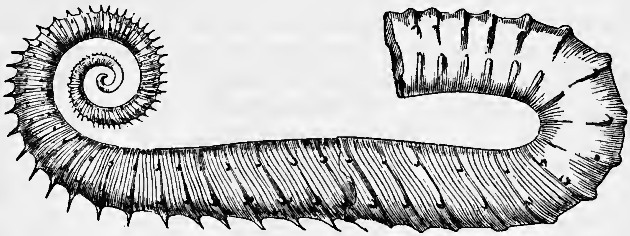


FIG. 78.—*Ancyloceras Matheronianum*, D'Orb. Neocomian.

spines, and tubercles. *Crioceras* extends from the Neocomian to the Upper Greensand, *Ancyloceras* (Fig. 78) from the Inferior Oolite to the Chalk.

Table-case 63.

Section II.—This section includes Ammonites of flat, disc-like form, with *Ceratites*-like sutures and deeply embracing whorls.

FIG. 79*a*.—Ammonite with aptychus in aperture of shell. Jurassic.

FIG. 79*b*.—Aptychus of an Ammonite detached. Jurassic.

*Sphenodiscus* and *Buchiceras* (Upper Cretaceous) are characteristic genera. *Placenticeras* (Cretaceous) includes such species as *P. Largilliertianum* and *P. Orbignyanum*.

Many examples of *Aptychi* are to be seen in the cases with the Ammonites. The *Aptychus* is the *shelly* (or in some cases *horny*) *operculum* closing the aperture of the shell in those genera of

Ammonites in which the animal could retreat wholly within the body-chamber of its shell. It was secreted by the coalesced pair of dorsal arms, and corresponds with the thick muscular hood which closes the mouth of the shell in the living *Nautilus*. Aptychi occur in the Chalk, the Kimeridge Clay, the Solenhofen beds, the Oxford Clay, the Inferior Oolite, and Lias (see Figs. 79*a*, *b*).

**GALLERY VII. Table-cases 62, 65–68.**

PTEROPODA, ETC.—The Pteropods ("Sea Butterflies" or "Winged Snails") are found swimming near the surface in the open sea, the living forms being all of small size. They have no distinct head; the mouth is placed anteriorly in the centre of the forepart of the foot, which is often rudimentary, but may be drawn out into one or more pairs of tentacles and provided with suckers. The lateral parts of the foot are expanded into a pair of wing-like muscular lobes, which are used as paddles. The hind portion of the foot is often rudimentary, but may carry an operculum. The Pteropods are divisible into two sections, the *Gymnosomata* and the *Thecosomata*; in both sections the embryo is provided with a shell, but in the *Gymnosomata* this is soon lost and the adult is devoid of any shell, while the adult members of the other section (*Thecosomata*) generally possess a very delicate external calcareous shell, of which the embryonic shell usually forms the initial portion. In the majority of the Pteropods the shell is symmetrical, but in some (*Limacinidæ*) it is coiled into a spiral. The Pteropods are all hermaphrodite. They have been heretofore regarded as a distinct class of the Mollusca, but recent investigations show that their internal organization does not essentially differ from that of certain of the Gasteropoda.

Indubitable Pteropods are found in the Tertiary deposits,[1] but the Mesozoic rocks have not yielded any true Pteropods, and it is not until we come to the Devonian and Silurian strata that forms closely resembling the recent genus *Styliola* (*Creseis*) are met with; the Pteropodal nature of these has, however, been disputed. These delicate calcareous shells have a conical form, and no partitions; they occur in abundance in some of the Devonian rocks of North America.

**Table-case 72.**

Three important Palæozoic genera, *Tentaculites*, *Hyolithes*, and *Conularia*, have often been grouped with the Pteropoda. The first

[1] The undoubted Tertiary Pteropods have been removed from this case and placed with the other Foreign Mollusca in Wall-cases 1–4 in Gallery VIII.

**GALLERY VII. Table-case 72.**

has been by some placed in the Annelida; the systematic position of the whole of these older forms is still, however, uncertain.

**See GALLERY VIII. Wall-case 1.**

Fig. 80.—*Vaginella depressa*, Bast. Miocene: Bordeaux.

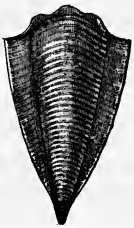


Fig. 81.—*Balantium recurvum*, Childr. Recent: Atlantic.

Fig. 82.—*Hyalæa tridentata*, Gmel. Recent: Atlantic and Mediterranean. Miocene: Turin, Sicily, and Dax.

**GALLERY VII. Table-case 72.**

In *Hyolithes* (= *Theca*) the shell is conical, usually straight, sometimes slightly curved, triangular in section, generally smooth, or with only fine transverse striæ; often provided with an operculum. The species vary in size, being usually an inch or an inch and a half long. They range from the Cambrian through the Ordovician and Silurian to the Devonian, and more rarely occur also in the Carboniferous and Permian rocks.

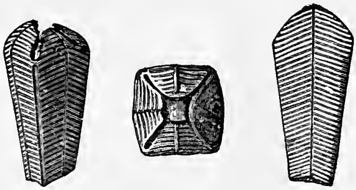



Fig. 83.—*Conularia quadrisulcata*, Sby. Coal-measures: Coalbrookdale. *a*, side-view; *b*, back; *c*, mouth or aperture of shell. The lower extremity is broken off.

In *Conularia* (Fig. 83) the shell is pyramidal in form, tetragonal in section; each face has a median furrow and is ornamented with transverse smooth or tuberculated ridges, each ridge being angulated in the centre of the face, the apex being directed towards the aperture. The latter is partially closed by an infolded prolongation of each face. The genus occurs in the Ordovician, Silurian, and Devonian, more rarely in the Carboniferous and the Permian formations; one species has been recorded from the Trias and another from the Lias.

## GALLERY VIII.

### II–V.—Scaphopoda, Amphineura, Gasteropoda, and Lamellibranchiata.

The fossil shells belonging to these groups of Mollusca occupy the whole of the west, or left-hand side, of this Gallery. The foreign specimens are arranged upon the sloping shelves of the Wall-cases 1–9, and the British Mollusca occupy the Table-cases 89–104. The Gasteropods, or Univalves, are placed first in each case,[1] then follow the Lamellibranchs (or Pelecypods); the whole series being subordinately arranged in stratigraphical order, commencing with the most recent deposits, such as raised beaches, glacial beds, etc., and going back in time to the Silurian and Cambrian formations. Those British and foreign specimens which are too large to be placed in either of the tableted series, are mounted on blocks and arranged upon the higher shelves at the back of the wall-cases according to their stratigraphical division. All figured and described specimens are indicated by a small green disc. **GALLERY VIII. West Side. Wall-cases 1–9, Table-cases 89–104.**

The British Post-Pliocene non-marine mollusca are grouped according to localities and occupy a separate, narrow, upright, glazed case in the centre of the Gallery, near Table-case 104. **Table-case 104.** These are succeeded by the Pliocene shells of the "Norwich," the "Red," and the "Coralline" Crags; under the latter are arranged the species from St. Erth, Cornwall. Some fine examples of *Voluta Lamberti* (Fig. 92) are placed in Table-case 102. One of these measures $9\frac{1}{2}$ inches in length (=240 mm.); they are from the Coralline Crag of Gomer, Suffolk. In the half of this case are placed the Oligocene Mollusca from the Isle of Wight and Hampshire. Noticeable among these is the *Amphidromus* (*Bulimus*) *ellipticus*, Sby., from Headon Hill (Fig. 93). **Table-cases 102 & 103.**

Table-cases 100 and 101 contain the Upper, Middle, and Lower Eocene shells from the London and Hampshire basins; these include the Barton, Bracklesham, and London Clay series, etc. Many of the specimens have been figured by Mantell, Sowerby, F. E. Edwards, and others: these all bear a small green disc. **Table-case 102.**

A slab of Headon Limestone (Oligocene) almost entirely composed of the shells of one fresh-water snail, the *Limnæa longiscata*, is fixed in a glazed frame on the wall between Wall-cases 2 and 3.

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[1] The Scaphopoda (*Dentalium*) and Polyplacophora (*Chiton*, etc.), being few in number, are not separated in the cases, but are arranged with the Gasteropods.

**GALLERY VIII. West Side. Slabs near Wall-cases 4 & 5.** A mass of rock of Lower Eocene age from Fareham, Hants, full of the shells of *Pinna affinis*, and another from the same formation with shells of *Axinæa brevirostris*, etc., are placed between Wall-cases 4 and 5.

Opposite Table-case 98, is a fine slab of "Bognor Rock" from the Lower Eocene of Sussex, largely composed of shells or the casts of shells of *Cardita Brongniarti*, *Axinæa brevirostris*, *Modiola elegans*, *Voluta denudata*, *Pyrula Smithi*, *Natica Hantoniensis*, and *Vermetus Bognoriensis*.

**Table-case 99.** Cretaceous Mollusca.—The British Cretaceous series of shells is rich in specimens described by Mantell, S. Woodward, Sowerby,

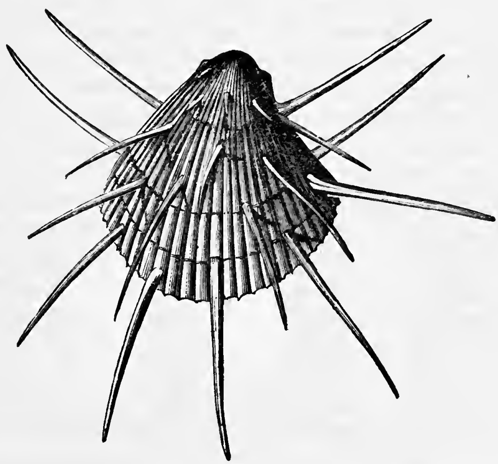

Fig. 84.—*Spondylus spinosus*, Sby. Upper Chalk: Gravesend.

etc. Notice the fine series of *Inoceramus* from the Chalk—Table-case 99 and Wall-case 5a. This genus is only met with in the Secondary period. Specimens of *Inoceramus Cuvieri* measure 18 inches across. Other Chalk species are *Spondylus spinosus* (Fig. 84) and *Neithea quinquecostata* (Fig. 86).

**Table-case 98.** There is a beautiful series of silicified shells from the Blackdown beds of Devonshire placed in Table-case 98. The shells from the Gault of Folkestone, from Black Ven, near Lyme Regis, from Okeford Fitzpaine, Dorset, deserve attention; the Scalidæ

and ALARIIDÆ among the Gasteropods and the *Nuculæ* and *Inocerami* (Lamellibranchs) are most interesting. **GALLERY VIII. West Side.**

FIG. 85—*Inoceramus sulcatus*, Park. Gault: Folkestone.

FIG. 86.—*Neithea quinquecostata*, Sby. Lower Chalk: Lewes, Sussex.

In the next case are the Lower Greensand (Aptian), Urgonian, and Neocomian Mollusca from Punfield, Atherfield, Tealby, Speeton, etc. Some fine examples of *Exogyra sinuata* may be seen (one in section shows the great thickness of the shell produced by age). Another striking form is the large *Pecten cinctus* from the Tealby beds, Lincolnshire; *Cucullæa Gabrielis*, from the Atherfield beds, is also of great size. Of the Gasteropods may be named *Vicarya Pizcuetana*, *Ceratosiphon Fittoni*, etc. **Table-case 97.**

The fluviatile shells of the Wealden (Neocomian) include many examples of the genus *Unio*, the largest being the *Unio valdensis* from Sussex and from Brook Point, Isle of Wight. In the centre of the gallery is placed a fine slab of "Petworth Marble," entirely composed of the shells of a fresh-water snail, *Viviparus* (*Paludina*) *fluviorum*, Sby. The elegant columns of the Temple Church, Fleet Street, are made of this marble from the Weald of Sussex. **Table-case 96.**

JURASSIC MOLLUSCA.—The British Jurassic shells occupy Table-cases 91–96. Many of them are figured specimens and illustrate the works of Phillips, Morris and Lycett, Damon, Hudleston, and others. Some of the genera, such as *Astarte*, *Lima*, etc., attained a large size when compared with their living representatives. Among the most striking specimens are *Pecten lamellosus* and *Trigonia gibbosa*, from the Portland beds; *Astarte Hartwellensis* and *Pleurotomaria reticulata*, from the Kimeridge Clay; *Bourguetia striata*, *Nerinæa Goodhalli*, *Trigonia* **Table-cases 91–96.**

**GALLERY VIII. West Side.** *triquetra*, *Gervillia Bronni*, from the Coralline Oolite; *Alaria bispinosa* and *Pachyrisma grandis*, from the Great Oolite; *Pleurotomaria* (represented by many species), *Amberleya Orbignyana*,

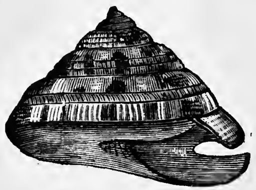

FIG. 87.
*Pleurotomaria Quoyana*, F. & B.
Recent: West Indies.

FIG. 88.
*Pleurotomaria platyspira*, D'Orb.
Mid. Lias: France.

*s* marks the position of the slit; the band which encircles the whorls of the shell marks the earlier portion of the slit, now filled up by shell-growth.

*Neritopsis Baugieriana*, *Pinna ampla*, *Trichites undata*, *Trigonia*, *Astarte*, and *Pholadomya*, of which there are many species, from

FIG. 89.—*Hippopodium ponderosum*, Sby.
Lias: Gloucestershire.

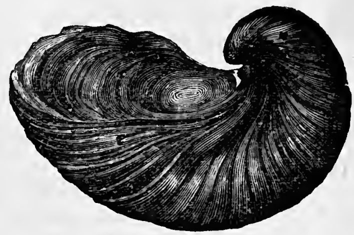

FIG. 90.—*Gryphæa incurva*, Sby.
Lias: Lyme Regis.

the Inferior Oolite[1]; *Gryphæa incurva* (Fig. 90), *Oxytoma cygnipes*, *Hippopodium ponderosum* (Fig. 89), *Cardinia Listeri*, *Pleurotomaria anglica*, from the Lias.

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[1] A series of Inferior Oolite Gasteropoda is temporarily arranged in a small table-case in the centre of this Gallery near Table-case 92.

Opposite Table-case 94, in the centre of the gallery, is a large block of Portland Oolite from the "Roach-bed," Isle of Portland, almost entirely composed of the casts of *Trigonia gibbosa, Natica elegans, Cardium dissimile,* etc. **GALLERY VIII.**

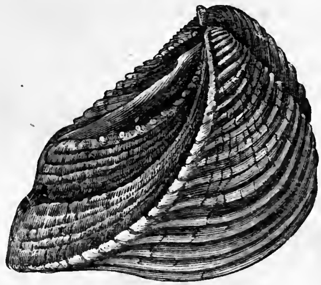

Fig. 91.—*Trigonia costata,* Park. Oxfordian: Osmington, Dorset.

Between Wall-cases 5 and 6, two slabs of Portland Oolite are fixed on the wall: one contains *Perna Bouchardi* and *Pecten lamellosus*; the other is full of the casts of *Cerithium concavum.*

A slab of Kimeridge Clay placed on the wall between Wall-cases 6 and 7 exhibits fine specimens of *Ostrea læviuscula*; there is also a block of Coralline Oolite full of specimens of *Trigonia clavellata* from near Weymouth. In Table-case 91 are placed specimens of *Pecten Valoniensis* from the Rhætic of Westbury Cliff, and *Trochus Waltoni* from Beer, Somerset; also impressions of Mollusca from the Upper Keuper of Warwickshire; and remains of *Monotis, Schizodus, Rissoa,* etc., from the Permian of Durham. **Table-case 91.**

Palæozoic Mollusca.—Table-case 90 contains the Carboniferous and Devonian Mollusca; of the former may be mentioned *Anthracosia, Carbonicola, Myalina,* etc., from Coalbrookdale, figured and described by Sowerby in Prestwich's "Geology of Coalbrookdale." The Gasteropods include *Euomphalus, Leveillia, Bellerophon,* etc. The Devonian Mollusca are represented by *Anodonta Jukesii* and the genus *Murchisonia.* The Silurian and older Mollusca comprise the genera *Euomphalus* from the Wenlock Limestone, with its operculum *in sitû*; *Trematonotus,* with a central series of perforations; *Maclurea* from the Durness Limestone (Ordovician) of Scotland. From the Cambrian are forms referred to the genera *Glyptarca* and *Palæarca,* etc. **Table-case 90.** **Table-case 89.**

GALLERY VIII.

Key to the Table-cases containing the collection of fossil shells of *British Gasteropoda and Lamellibranchiata*, including those table-cases arranged in the centre of Gallery.

Table-case.

104A. British Post-Tertiary Land and Fresh-water Mollusca.
104. Post-Tertiary (Marine), Pliocene (Norwich Crag).
103A. Pliocene (Norwich, Red, and Coralline Crags).
103. Pliocene (Norwich, Red, and Coralline Crags).
102. Pliocene (Coralline Crag), Oligocene (Hempstead to Headon Beds).
101. Eocene (Upper and Middle).
100. Eocene (Lower).
99. Chalk.
98. Upper Greensand and Gault.
97. Aptian (Lower Greensand), Urgonian, and Neocomian.
96. Wealden (Neocomian), Purbeck, and Portland Beds.
95. Kimeridge Clay and Coralline Oolite.
94. Oxford Clay, Kellaway's Rock, Cornbrash, Forest Marble, Bradford Clay, and Great Oolite.
93. Great Oolite, Fuller's Earth, and Inferior Oolite.
92. Inferior Oolite.
91. Lias, Trias, and Permian.
90. Carboniferous and Devonian.
89A. Foreign Palæozoic Mollusca.
89. Silurian, Ordovician, and Cambrian.

Wall-cases 1–9.

FOREIGN MOLLUSCA.—The Foreign Quaternary and Tertiary groups of Mollusca commence in Wall-case 1 with shells from raised beaches like those of Florida and Australia, and with Italian Pliocene shells. Then follow Miocene Mollusca from Bordeaux, from Muddy Creek, Victoria, and from South Australia (Wall-cases 2 and 3); next is the magnificent series of Eocene Mollusca from Paris, Grignon, and Epernay.

The shells of the Paris Basin exhibit strong affinity with those of the English Eocene; but the former are often more perfectly preserved and the species more abundant than in the latter deposits. Fine specimens of *Campanile* (*Cerithium*) *giganteum* (Fig. 94) from Grignon are placed in a glass case between Wall-cases 3 and 4, and others are mounted in the wall-case, together with a longitudinal section showing the shelly plaits upon the columella. In a glass case, between Wall-cases 2 and 3, is exhibited the shell of

a great *Cypræa* (*C. gigas*), from the Murray River (Miocene) beds **GALLERY VIII.** of Australia, which greatly exceeds in size the living *Cypræa* **Wall-cases** *cervus* from the Pacific, regarded as the largest living species. **5 & 6.**

The foreign Cretaceous shells occupy Wall-cases 5 and 6. There is exhibited here a fine series of *Radiolites* (*Hippurites*), shells allied to the existing *Chama*, which probably lived in clusters adhering to coral-reefs in the Cretaceous sea. They are rare in this country, but the "Hippurite limestone" is well developed in France, Spain, and

Fig. 92.—*Voluta Lamberti*, Sby. Coralline Crag: Gomer, Suffolk. (Reduced to $\frac{1}{8}$ nat. size.)

Fig. 93.—*Amphidromus* (*Bulimus*) *ellipticus*, Sby. Headon Hill, Isle of Wight. (Reduced to $\frac{1}{4}$ nat. size.)

Fig. 94.—*Campanile* (*Cerithium*) *giganteum*, Lamk. Eocene: Epernay, France. (Reduced to $\frac{1}{20}$ nat. size.)

Italy, and it often occurs in the East and West Indies, etc. On the wall are exhibited specimens of *Inoceramus expansus* from Cretaceous beds in Natal, South Africa. In the wall-case are placed shells of *Alectryonia ungulata*, *Neithea quadricostata*, *Pinna cretacea*; large *Nerinæa* from Spain; with *Cucullæa*, *Inoceramus*, *Gervillia*, *Trigonia*, etc. Numerous beautiful examples of *Trigoniæ* are here exhibited, ranging from the Lower Lias to species living at the present day off the coast of Australia.

The next case (No. 7) contains the series of foreign Oolitic **Wall-** shells. There is a fine series (part of the Tesson Collection) **case 7.** from the Lower Oolite of Normandy, agreeing closely with those from British localities of a similar age. Amongst the Gasteropods are *Trochus*, *Neritopsis*, *Amberleya*, *Nerita*, *Pleurotomaria*, etc., the bivalves being represented by *Astarte*, *Trapezium*, *Opis*, *Trigonia*, *Pholadomya*, *Ceromya*, etc.

The succeeding wall-cases (Nos. 8 and 9) contain the Mollusca **Wall-cases** from the Lias and Trias, followed by the Palæozoic series, Permian **8 & 9.** to Silurian. *Lithotrochus Humboldti*, from the Lias of South America, and *Trigonia navis*, from Germany, may be referred to.

GALLERY VIII. West Side. Wall-cases 8 & 9.

Attention is also called to the series of Mollusca from the Trias of St. Cassian (collected by Klipstein), of which *Myophoria* is a prominent genus, related to *Trigonia* in some of its characters. The Permian shells are chiefly from Gera, Germany, and include *Schizodus*, *Pleurophorus*, *Pleurotomaria*, *Chitonellus*, etc. The Permo-Carboniferous series is represented by specimens from Australia of the genera *Platyschisma*, *Pachydomus*, *Eurydesma*, *Orthonota*, *Conocardium*, etc.; several of these are types figured in Strzelecki's Memoir, 1845. The Carboniferous of Belgium is represented by the genera *Euomphalus*, *Loxonema*, *Chiton*, *Conocardium*, *Pinna*, etc.; the Devonian of Germany by *Murchisonia*, a banded shell related to *Pleurotomaria*, and by *Megalodon cucullatus*. The Silurian genera from Bohemia exhibited are *Tubina*, *Capulus*, *Polytremaria*, *Conocardium*, etc., part of the Barrande Collection.

There is a small table-case in the centre of the gallery, placed near to Table-case 89, containing a series of foreign Palæozoic Gasteropods belonging to the families Bellerophontidæ, Pleurotomariidæ, and Solariidæ.

GALLERY VIII. East Side. Wall-cases 10 & 11, Table-cases 86–88.

## II.—ANNULOSA.

### I.—BRACHIOPODA.

The Brachiopoda are animals that live in the sea, and have a soft body enclosed in an external shell with two valves. They thus look something like bivalve Mollusca; but both the

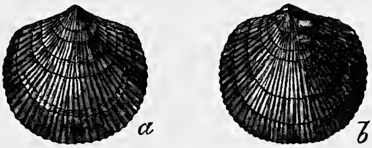

Fig. 95.—*Atrypa reticularis*, Dalman. Silurian and Devonian. *a*, dorsal or peduncular valve; *b*, ventral or brachial valve. Shows bilateral symmetry, and slightly greater size of dorsal valve.

shell and the soft parts have really a very different structure from those of the Mollusca. So much of the anatomy of the Brachiopoda as is important to the student of fossils, is illustrated by the large coloured diagrams in Wall-cases 10 and 11.

Wall-cases 10 & 11.

The two valves of the shell lie on the back and front of the animal, not on its sides as in bivalve molluscs. Each valve is symmetrical

**GALLERY VIII. East Side. Wall-cases 10 & 11, Table-cases 86–88.**

in itself, its right and left halves resembling one another. On the other hand, one valve is nearly always larger than the other (Fig. 95*a*). By the larger valve the adult animal is usually attached to rocks or other objects. In a few forms, such as *Crania* (Diagram 1), the valve is directly cemented to the rock by its own substance. In others, such as *Lingula* (Diagram 2 and Fig. 100), the valve is attached by a long muscular stalk, the "peduncle" or "pedicle," which is capable of waving movement and of contraction. There are also intermediate stages, with shorter peduncles, such as *Hemithyris* (Diagram 8) and *Discina* (Fig. 97). This larger, attached valve is therefore often called the "peduncle valve": by English writers it is called the "ventral valve," although in the natural position of stalked forms it is always the uppermost. Similarly the smaller valve is called the "dorsal valve"; but a better name is "brachial valve," which reminds one that this valve often bears a calcareous skeleton supporting the so-called "arms" (Diagram 9 and Figs. 101 and 102).

In microscopic structure also the shell differs from that of the Mollusca (Diagram 3). It is mainly composed of small prisms of calcite (carbonate of lime), which usually lie at right angles to the surface of the shell. In the harder-shelled forms these make up the greater part of the shell, merely being coated on the surface with a layer of slightly different texture and with a thin horny membrane, the "periostracum." In the softer-shelled forms, such as *Lingula*, horny substance occurs not merely on the surface, but in layers between the prisms, which in this case are of phosphate of lime. In many genera, such as *Terebratella, Crania, Cistella,* the shell is perforated by a number of small canals; these contain processes of the mantle, the arrangement of which is shown in Diagram 3*a*. In fossils this structure gives to the exterior of the shell a pitted or "punctate" appearance under a magnifying glass, and thus enables one to distinguish such shells from those which are "impunctate," as the shells of Atrypidæ and most Rhynchonellidæ.

In those Brachiopoda that appear to be the simplest and oldest, the shells are not as a rule joined by any hinge (Diagram 7). These have therefore been called INARTICULATA or ECARDINES[1]: they include *Lingula*, *Discina*, *Obolus*, *Crania*, *Trimerella*, and their allies. In more advanced forms, such as *Orthis*, *Leptæna*, *Atrypa*,

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[1] *E*, without; *cardo*, a hinge.

**GALLERY VIII. East Side. Wall-cases 10 & 11, Table-cases 85–88.**

*Terebratula*, a hinge is developed at the hinder end of the shell (Diagram 4). These have therefore been called ARTICULATA or TESTICARDINES.[1] As classificatory divisions, however, these are not altogether satisfactory, for the Articulata are necessarily derived from the Inarticulata, and intermediate forms are not rare.

In the relations of the peduncle to the valves one can trace a gradual evolution. The simplest type is seen in *Paterina* (from the Cambrian, Fig. 96) and *Lingula* (Cambrian to present day, Fig. 100),

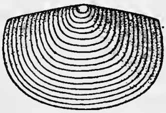

FIG. 96.—*Paterina Labradorica*, Billings, sp. Cambrian.
An example of the Atremata, and the simplest known form of Brachiopod shell.

where the peduncle simply passes out between the valves and is not enclosed by either of them; there is therefore no hole, or *trema* (τρῆμα), through which the peduncle may pass, and such genera constitute the order ATREMATA. In *Trematis*, *Discina* (Fig. 97), *Siphonotreta*, and their relatives (mostly Ordovician and Silurian), the peduncle is restricted to the ventral valve; it lies in a groove or

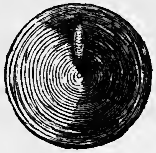

FIG. 97.—*Discina circe*, Billings. Ordovician.
An example of the Neotremata.
The peduncular valve, showing the delthyrium, which has become surrounded by the valve, and is also partly filled in from underneath by a shelly deposit.

fissure ("delthyrium"), which remains open in primitive forms, but closes round the peduncle (forming a τρῆμα) in later forms: such genera constitute the order NEOTREMATA. Next, the fissure or "delthyrium" in which the peduncle lies, assumes a triangular shape; the peduncle lies towards the apex of the triangle, and itself secretes a single shelly plate ("pseudo-deltidium"), which

[1] *Testa*, a shell; *cardo*, a hinge.

gradually fills up the triangular fissure till only a small foramen is left at its apex, as in *Clitambonites* (Fig. 98) and *Rafinesquina* (Diagram 4); later in life the pseudo-deltidium may be reabsorbed,

**GALLERY VIII. East Side. Wall-cases 10 & 11, Table-cases 86–88.**

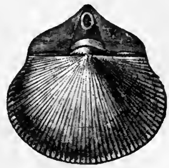

FIG. 98.—*Clitambonites Verneuili*, Eichw., sp. Ordovician.
An example of the Protremata.

The shell is seen from the side of the brachial valve, above which is the lofty hinge-area of the peduncle valve. The delthyrium is covered by a single pseudo-deltidium, through which the peduncle passed by the foramen (K).

as in the Orthidæ: such genera constitute the order PROTREMATA. Some forms have taken another line of evolution: in them the pseudo-deltidium is either absent or soon reabsorbed, so that the delthyrium is open in early life, but at a later period it becomes partly or entirely closed by two "deltidial plates," which are secreted by the edges of the mantle along the sides of the delthyrium, and which may subsequently meet either above or below the peduncle, and may even fuse into one plate, the "deltidium"; these plates are well seen in *Atrypa* (Fig. 95) and *Stringocephalus*, and occur in *Rhynchonella*, *Spirifer* (Fig. 101), *Terebratula*, and allied forms: such genera constitute the order TELOTREMATA.

The orders Atremata and Neotremata are equivalent to successive stages of the Inarticulata, and are most abundant in the earlier Palæozoic rocks. From them the Protremata and Telotremata arise as divergent groups, which together are the equivalent of the Articulata. The Protremata were dominant in later Palæozoic time; the Telotremata in Mesozoic.

The shell-valves are secreted by the two mantle-folds which line them. These are extensions of the body-walls, and they contain prolongations of the body-cavity, in which is a blood-like fluid and in which the generative products are formed. These vessels often produce impressions on the inside of the shell, and so can be traced in the fossils, e.g. *Camarophoria* (Fig. 99) and a fine specimen of *Orthis* (*Schizophoria*) *striatula* in the wall-case.

**GALLERY VIII. East Side.**

**Wall-cases 10 & 11, Table-cases 86–88.**

The outer edges of the mantle-folds are set with bristles ("setæ"). These structures are shown in Diagrams 5 and 11.

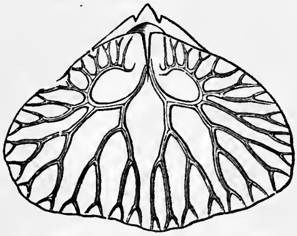

FIG. 99.—*Camarophoria Schlotheimi*, Buch, sp. Permian. Ventral side of internal cast, showing the impressions of vessels in the mantle-fold.

Muscles pass across the body of the animal from one shell-valve to the other (Diagram 6); they serve to open and to close the valves, and to move them sideways. The attachment of these muscles to the shell forms scars, and in fossil Brachiopods these scars are the only evidence we have as to the arrangement of the

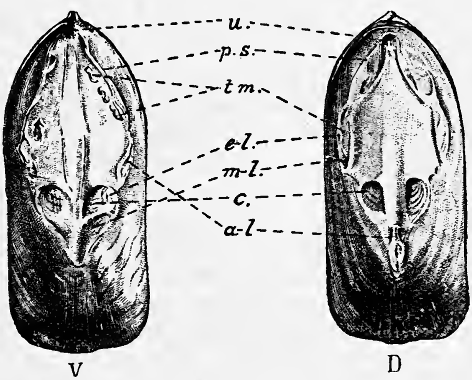


FIG. 100.—*Lingula anatina*, Lamk. Recent seas. Interior of V, ventral or peduncular valve, and D, dorsal or brachial valve, to show muscle-scars, which are denoted thus: *u.* umbonal; *p.s.* parietal; *tm.* transmedian; *e.-l.* externo-lateral; *m.-l.* medio-lateral; *c.* central; *a.-l.* antero-lateral.

muscles. It is therefore important to understand the meaning of these scars; and to help the student, a very careful drawing from life of the inner surface of a *Lingula* shell has been made (Diagram 7 and Fig. 100), which may be compared with the adjacent diagram showing the muscles.

The viscera lie near the hinder or peduncular end of the shell, and the mouth is directed towards the forepart or opening of

**GALLERY VIII. East Side.**

**Wall-cases 10 & 11, Table-cases 86–88.**

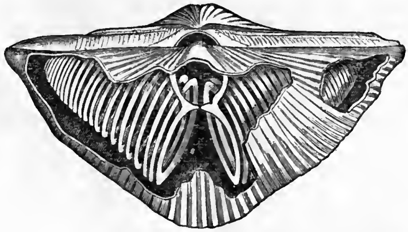

FIG. 101.—*Spirifer striatus*, Sby. Carboniferous Limestone.
An example of the spire-bearing Telotremata.

The shell is seen from the side of the brachial valve, and portions of that valve are broken away, exposing the spires that support the arms of the lophophore. Between the umbones of the peduncular and brachial valves is seen the delthyrium, partly filled in by the deltidial plates that have met and fused above the foramen into a single deltidium.

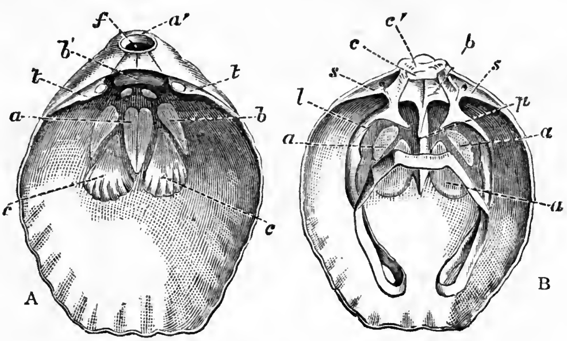


FIG. 102.—*Magellania flavescens*, Lamk., sp. Recent seas, Australia.
An example of the loop-bearing Telotremata.

A.—Interior of peduncle valve. *f*, foramen for peduncle, below which are seen the two deltidial plates; *t*, teeth of hinge; *a*, *b*, *c*, muscle-scars; *b'*, scar of peduncular attachment.

B.—Interior of brachial valve. *c*, *c'*, cardinal process for attachment of muscles; *b*, hinge-plate, supporting cardinal process and prolonged below into *p*, the median septum; *s*, sockets for the teeth of the peduncle valve; *l*, loop, supporting lophophore; *a*, muscle-scars.

the shell. The mouth is surrounded by a somewhat horseshoe-shaped disc; this bears tentacles that are furnished with minute, rapidly-moving processes known as "cilia," which drive towards

**GALLERY VIII. East Side. Wall-cases 10 & 11, Table-cases 86–88.**

the mouth currents of water containing food-particles; it is called the "lophophore" (tuft-bearer), and resembles the structure of the same name in the Bryozoa (Diagram 8). This lophophore is often produced into two processes, which fill the forepart and sides of the shell-cavity and are often spirally coiled. These processes are generally known as "arms," and, since they were formerly supposed to represent the "foot" of the Mollusca, their presence suggested the name Brachiopoda (βραχίων, an arm; and πούς, a foot). The arms are often supported by a calcareous skeleton, the shape of which is of great importance in classifying fossil Brachiopods. Thus, the Telotremata branched into loop-bearing forms (Diagram 9 and Fig. 102, *Magellania*) and spire-bearing forms (Diagram 9, *Atrypa*, and Fig. 101, *Spirifer*).

The mouth leads to a slightly coiled intestine (Diagram 10), which in the Inarticulata is provided with an anus (whence this class has also had the name Tretenterata[1] applied to it). It seems that some of the earlier Protremata were also provided with an anus; but in the later Articulata this structure became degenerate, and no longer exists in the living representatives of the class; for them, therefore, the name Clistenterata[2] was proposed.

The Brachiopoda possess a system of blood-vessels with a contractile heart, a distinct nervous system, and a pair of excretory organs ("nephridia"), which serve also for the transmission of the generative products (Diagram 11). The sexes are usually separate.

The Brachiopoda are found in seas all over the world, and usually at depths of less than 100 fathoms, but they have been dredged at a depth of 2,900 fathoms. Most attach themselves permanently to a hard bottom by the peduncle, open their shell so far as the hinge permits, and collect minute food-particles in the currents of water that flow down the lophophore. Some protrude and even unroll the arms. *Lingula*, as shown in Diagram 2, lives in a tube in the sand, forming a case of agglutinated sand around the lower end of its peduncle; it stretches its shell to the opening of the tube, and the projecting setæ guide the currents of water down to the lophophore; but

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[1] Meaning "pierced guts."
[2] Meaning "closed guts."

when disturbed, the peduncle contracts and the shell is withdrawn into the tube, which closes in above. It is not, however, to be inferred that all extinct species of *Lingula* and of similar genera lived in this way.

**GALLERY VIII. East Side. Wall-cases 10 & 11, Table-cases 86–88.**

Though Brachiopods usually occur in great numbers wherever found, they are not so numerous now as they were in past ages. In the Carboniferous period especially, the number of species and individuals was very great, and the *Producti* then living reached a larger size than any Brachiopod before or since. Specimens may be seen on the upper shelves of Wall-case 10. *Terebratula grandis*, of the Coralline Crag, is the largest Brachiopod found in later rocks.

In this Gallery the British fossil Brachiopoda are arranged in Table-cases 86–88, in stratigraphical order. The important British specimens, forming the types of Davidson's great monograph, are, however, exhibited in Gallery XI. Here are also placed the numerous type-specimens of Sowerby. The Davidson Collection contains many Brachiopoda from foreign localities, which are of great interest either as types or as showing structural characters. The general collection of foreign fossil Brachiopoda is placed in Wall-cases 10 and 11 of Gallery VIII. Among them the specimens of chief interest are those from the Palæozoic rocks of the Arctic regions and from Australasia.

**Table-cases 86–88.**

**Wall-cases 10 & 11.**

## II.—BRYOZOA.[1]

The Bryozoa are animals, including the Sea Mats, which live in either fresh or salt water, mostly in the latter. With one exception (*Loxosoma*), they always live in colonies, which are generally fixed. A colony consists of a large number of individuals (or zooids), each of which is completely separated from the rest and enclosed in a double-walled sac. The digestive tube is U-shaped, the mouth and anus being placed close together. A band of tentacles occurs around the mouth in most forms, but in one group (Entoprocta) this surrounds both the mouth and the anus. Unlike the Mollusca, to which the Bryozoa were once regarded as akin, they have only one nerve-ganglion.

[1] The name Polyzoa has been adopted for this class by many English authors.

**Bryozoa.**
**GALLERY VIII.**
**Centre-cases 86a & 86b, Wall-case 12a.**

Bryozoa are frequently found upon the seashore, either spreading in delicate gauze-like sheets over weeds, shells, and stones, rising in hard shrub-like tufts, forming hemispherical masses, or spreading in flexible horny branches. Owing to their mode of growth, they are generally mistaken for seaweeds. The classification of the Bryozoa depends upon the structure of the small "zooids," and the microscope is indispensable in their study. In the arrangement of the collection, therefore, specimens are exhibited to show the general form and "habit" of the colony, and drawings are placed beside them to show the minute structure of the zooids. The specimens are in most cases sufficiently near

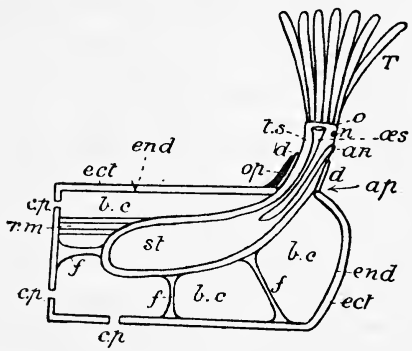



Fig. 103.—Diagram of structure of a typical Bryozoan zooid. *an.* anus; *ap.* aperture; *b.c.* body-cavity; *c.p.* communication pore; *d.* diaphragm; *ect.* ectoderm; *end.* endoderm; *f.* funiculi; *n.* nerve-ganglion; *o.* orifice; *œs.* œsophagus; *op.* operculum; *r.m.* retractor muscle; *st.* stomach; *T.* tentacles; *t.s* tentacle sheath.

**Wall-case 12a.**

to the front of the case to admit of the use of a magnifying glass, and thus the main features of the zooids can be recognized. Some of the colonies too large to be included in the table-cases are placed in Wall-case 12A.

Most of the living Bryozoa are soft-bodied animals, and only two, or possibly three, of the existing orders are represented in the fossil faunas. There are two other orders (the Trepostomata and Cryptostomata), which are now extinct. The fossils, however, all belong to the Gymnolæmata, one of the three main divisions of the Bryozoa.

The Bryozoa are abundant fossils in many formations, and

therefore, though the exhibition series of British species is fairly complete, only a few representatives of the foreign forms are exhibited. The main series of British Bryozoa are exhibited in two high tables in the centre of the gallery. Specimens too large for this series, and the foreign forms, are in Wall-case 12A.

**Bryozoa. GALLERY VIII. Centre-cases 86a & 86b, Wall-case 12a.**

Commencing with the central table-cases, we find in the first place a series of specimens from the Ordovician rocks of Wales. These are in an unsatisfactory condition of preservation, and they can only be determined by the assistance of better specimens yielded by rocks of the same age in America. One species is referred to the existing genus *Berenicea,* but the rest belong to two extinct orders—the Trepostomata and Cryptostomata.

In the Silurian deposits the Bryozoa are in more perfect condition, and the specimens from the Wenlock Limestone include some interesting and elegant forms, such as *Ptilodictya sublanceolata*, *Penniretepora Lonsdalei*, and several species of *Fenestella* and *Polypora.*

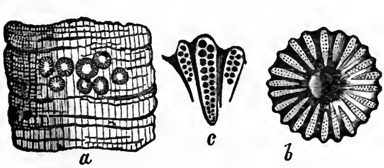



FIG. 104. — *Botryllopora sociale,* Nich. Devonian: Canada. *a,* portion of *Heliophyllum* with a small group of discs of *Botryllopora* adherent to it (nat. size). *b,* a single disc enlarged; *c,* one of the radiating ridges enlarged to show the cells.

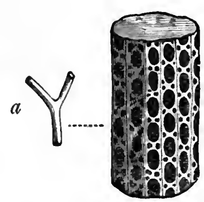



FIG. 105.—*Streblotrypa Hamiltonensis,* Nich., sp. Devonian: Canada. *a,* nat. size, and *b,* enlarged, to show the cells and the tubular intercellular interspaces.

The Devonian fauna is small, and the specimens are not well preserved; the type-specimen of *Fenestella prisca* (Phil.) is the best in the series. The Carboniferous Bryozoa, on the other hand, are numerous and in good condition. The most important genus is *Fenestella*; the size to which colonies of this attain is shown by two specimens mounted on blocks in Wall-case 12A. The fan-shaped species of this genus and of *Ptilopora,* the feather-shaped *Penniretepora,* and the cylindrical *Rhombopora,* are the most interesting forms in the table-case. *Hemitrypa* should not be overlooked, as it consists of a colony formed of two layers, of

**Wall-case 12a.**

**Bryozoa.**
**GALLERY VIII.**
**Centre-cases 86a & 86b, Wall-case 12a.**

which the upper was once regarded as a coral growing as a parasite on a *Fenestella*.

The Permian species are few in number, and the five chief species are illustrated by a representative series. Three specimens too large for the table-case are placed in Wall-case 12A.

The next fauna represented in England is that of the Jurassic system, which shows a great advance from that of the Palæozoic; old types such as *Fenestella, Penniretepora, Acanthocladia* disappear, and species belonging to existing genera form the largest part of the fauna. Among these, *Stomatopora, Berenicea,* and *Diastopora* are the most important, and are illustrated by an extensive series of specimens. These are associated with forms such as *Ceriopora,* which are survivals of the Palæozoic group of Trepostomata, and others such as *Theonoa* and *Apsendesia,* which are typically Mesozoic.

The ensuing Cretaceous fauna in many ways resembles the Jurassic. Trepostomata survive, and the Cyclostomata are still in the ascendancy. Examination, however, of the specimens exhibited, shows that the Cheilostomata are now fairly abundant, as we may see by the numerous species of *Membranipora* and *Onychocella,* and the presence of more specialized genera such as *Cribrilina.*

Passing to the Eocene, we find that the fauna in England becomes much smaller, though that of the Mediterranean Basin at the same period was very large. The forms, moreover, are scarce and dwarfed, as they lived in a sea exposed to the north and cut off from the warm waters of the Mediterranean by a land barrier across Central France and Germany. Hence genera such as *Idmonea* are represented only by small delicate colonies (see e.g. *Idmonea coronopus,* from the Paris Basin), which are in striking contrast to the massive growths found in Italy and Austria. The fauna is therefore aberrant, and includes a remarkably high percentage of peculiar species. Among these, *Orbitulipora petiolus,* consisting of a disc supported on a short stem (see *e.g.* specimen, B. 4349), *Adeonellopsis Wetherelli,* and *Notamia Wetherelli,* are the most interesting species; *Schizoporella magnoaperta, Smithia tubularis,* and *Entalophora tergemina,* are of interest as representing modern types of existing genera.

The Pliocene in England is much richer than the Eocene, and comparison need only be made between the small fragile specimens

from the latter with such massive colonies as those from the Crags, which owing to their size have to be placed in the wall-case (No. 12A), to realize that the Bryozoa were then living under more favourable conditions. In fact, the Arctic Ocean was probably cut off by a land barrier to the north, while there must have been free communication with the seas to the south. The collection in the Museum from this period contains the specimens used by Busk as the types of his monograph on the "Crag Polyzoa."

**Bryozoa. GALLERY VIII. Centre-cases 86a & 86b, Wall-case 12a.**

The most interesting forms found in the Crag are some massive Cyclostomata, including the three species known as *Alveolaria semiovata*, *Fascicularia aurantium*, and *F. tubipora*. Among the Cheilostomata, the most remarkable forms are two species of *Cellaria* (syn. *Salicornaria*) and one of *Melicerita*. The numerous species of *Schizoporella*, *Mucronella*, and *Membranipora* are closely allied to or identical with living forms.

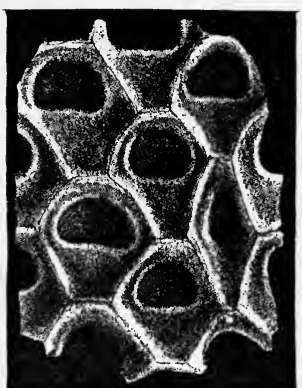


Fig. 106. — *Onychocella flabelliformis*, Lamx., sp. Bathonian: France.

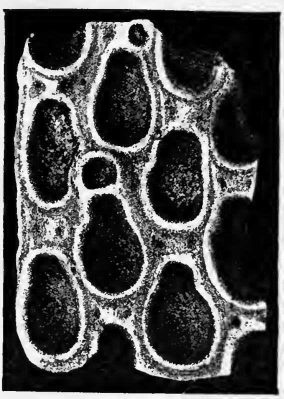


Fig. 107.—*Membranipora jurassica*, Greg. Bathonian: France.

A small collection of Pleistocene species from the Clyde and from Selsea Bill is exhibited; but all these species still live on the English Coast.

The foreign Bryozoa are exhibited in Wall-case 12A; but the collection is not yet arranged, and only a few representative species are exhibited. The lowest slope is devoted to the Palæozoic faunas, chief of which is that from the Silurian rocks of North

**Wall-case 12a.**

**Bryozoa.** **GALLERY VIII. Centre-cases 86a & 86b, Wall-case 12a.**

America; its importance to English students is largely due to the fact that it includes specimens belonging to genera found also in England, but which are here in such unsatisfactory preservation that their structure cannot be adequately determined.

The Carboniferous fauna of North America contains some remarkable forms, notably the screw-like *Archimedes Wortheni*, from Warsaw, Illinois, and *Evactinopora quinqueradiata*, from Burlington, Illinois.

A collection from the Bathonian deposits of Northern France on the middle slope contains several interesting forms, notably two species, *Membranipora jurassica* and *Onychocella flabelliformis*, which are the first known representatives of the true Cheilostomata.

Among the Tertiary Bryozoa, the large specimens from the Miocene deposits of the Mediterranean are most worthy of notice.

## (Division A.—ARTHROPODA.)

**GALLERY VIII. Wall-case 12, Table-case 85.**

This division comprises the Insecta, the Myriopoda, the Arachnida, and the Crustacea. In these animals the body is composed of a series of segments united together in a linear order and the number of which is usually definite. Each segment may have a single pair of jointed appendages articulated to it, and both are encased in a chitinous or calcareous covering more or less thick. The muscles, nerves, and internal organs are all enclosed within the hard external covering, which thus protects them from injury. The breathing organs, when present, may be in the form of gills or branchiæ, or pulmonary sacs or tracheæ.

## III.—TRACHEATA.

**Fossil Insects. Wall-case 12, Table-case 85.**

1.—Insecta (or *Hexapoda*). The Insects form the most specialized group of the Arthropoda. The head, thorax, and abdomen are distinct; there are three pairs of legs borne on the thorax; the abdomen has no limbs; the head bears a single pair of antennæ; most insects have two pairs of wings on the thorax, and they breathe by means of tracheæ.

The earliest known evidence of insect-life is the wing of a supposed cockroach discovered by Dr. Chas. Brongniart in the Middle Silurian of Jurques, Calvados, France, and named *Palæoblattina Douvillei*. The Coal-measures of Commentry, Allier,

France, have yielded by far the largest and most wonderful collection of fossil insects known, embracing Neuroptera, Pseudo-orthoptera, Orthoptera, and Homoptera. One dragon-fly from Commentry measures 28 inches in the spread of its wings. In the collection are displayed examples of cockroaches from the **GALLERY VIII. East Side. Wall-case 12, Table-case 85.**

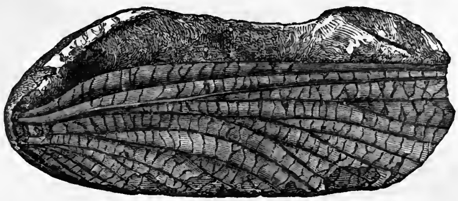


Fig. 108.—Wing of *Corydalis Brongniarti*, Mantell. Coal-measures: Coalbrookdale, Shropshire.

Coal measures of Dudley; of the wings of *Brodia priscotincta*, from Tipton, Staffordshire (Fig. 109), showing colour-spots; of *Lithomantis carbonarius* (Woodw.), from the Coal-measures of Scotland; of *Corydalis Brongniarti*, from Coalbrookdale (Fig. 108); and many other examples.

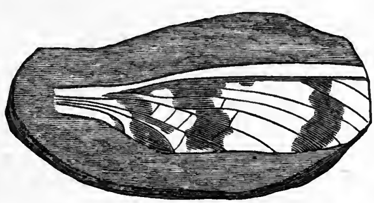


Fig. 109.—Wing of *Brodia priscotincta*, Scudder. Coal-measures: Tipton, Staffordshire. Showing evidence of colour-bands on the wing.

In the Lithographic Stone (Lower Kimeridgian) of Solenhofen and of Eichstatt, Bavaria, numerous very beautiful and well-preserved insect-remains have been met with; many of these may be seen in Wall-case 12. The most interesting are the remains of numerous Libellulæ (Dragon-flies); of *Pygolampis gigantea*, Münster; of *Cicada*, *Gryllacris*, etc. Insects occur in the Stonesfield Slate and in the Purbeck Beds: see Table-case 85. **Table-case 85.** In the Tertiary strata remains of insects are very numerous, and comprise almost every existing type. Fossil-remains of many

**GALLERY VIII.**
**East Side.**

**Wall-case 12, Table-case 85.**

Some Fossil Cockroaches from the Coal-measures.

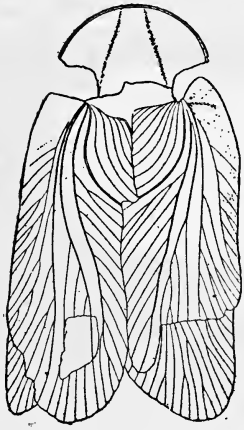


Fig. 110.—*Etoblattina Mazona*, Scudder. Carboniferous: Illinois, U.S.

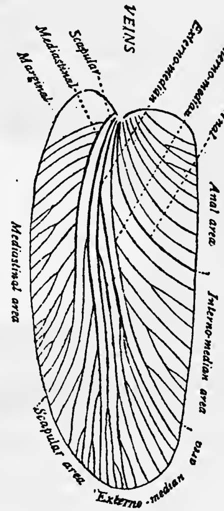



Fig. 111.—Names of veins in the wing of a Palæozoic Cockroach. (After Scudder.)

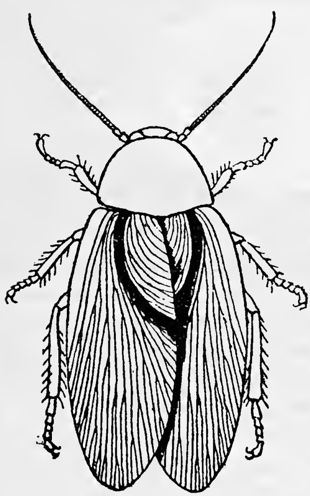


Fig. 112.—*Progonoblattina Helvetica*, Heer, sp. Carboniferous: Switzerland. (Restored.)

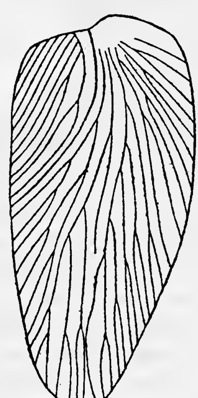


Fig. 113.—Wing of Cockroach, *Mylacris anthracophilum*, Scudder. Carboniferous: Illinois, U.S.

species may be seen from the Eocene of the Isle of Wight; from the Miocene of Œningen, Switzerland; from the Brown Coal of Bonn; from Aix, in Provence; from Haring, in the Tyrol; from the Baltic Amber deposits; and from Florissant, in North America.

**GALLERY VIII. East Side. Wall-case 12, Table-case 85.**

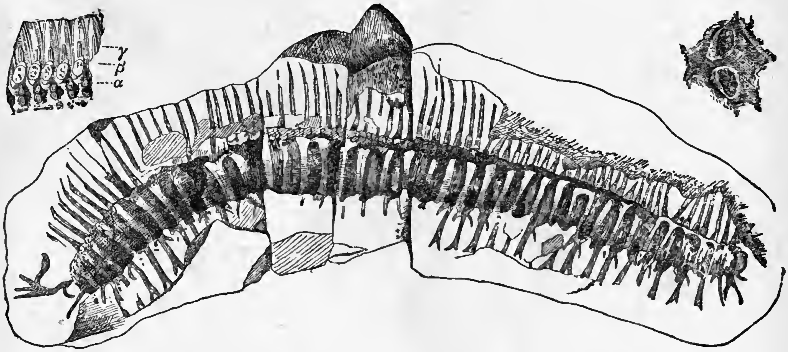



FIG. 114.—*Acantherpestes major*, M. and W. Coal-measures: Illinois, U.S.A. Showing the legs and the branched spines and branchial openings. (Nat. size.)

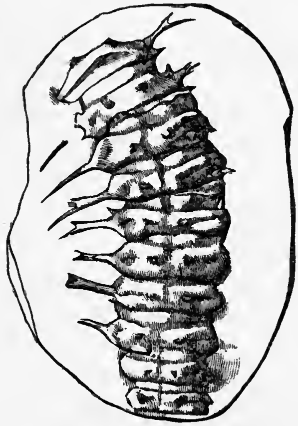


FIG. 115.—*Euphoberia ferox*, Salter. Coal-measures: Coalbrookdale, Shropshire. (Nat. size.)

2.—In the MYRIOPODA the head is distinct, but the remainder of the body is composed of a series of similar segments, and there is no

**GALLERY VIII. East Side. Wall-case 12, Table-case 85.**

distinction between the thorax and the abdomen; there is one pair of antennæ, and the number of legs is more than eight pairs. This division is represented by the Centipedes and Millipedes; and the earliest examples known fossil occur in the Coal-measures (Figs. 114, 115). Some North American species were of large size, and the body was armed with a row of branched spines. Specimens of them, named *Euphoberia armata*, from Tipton, Staffordshire, and others of *E. Brownii*, from Glasgow, are exhibited in Table-case 84.

3.—In the Arachnida are included Spiders, Scorpions, Mites, etc. The body is composed of a variable number of segments, some of which carry jointed appendages. The Arachnida breathe by pulmonary vesicles or sacs, or by ramifying tubes fitted for

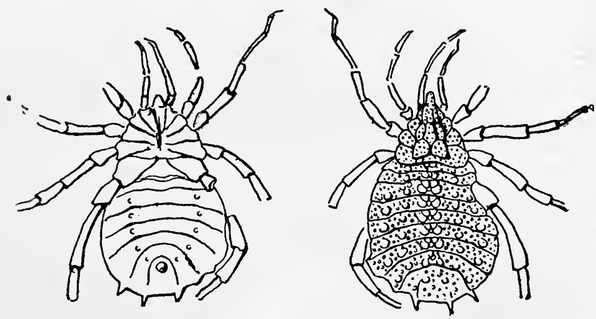
b  a

Fig. 116.—*Eophrynus Prestvicii*, H. Woodw., sp. (*a*) the upper and (*b*) the under side of the same specimen; preserved in a nodule of clay ironstone, from the Coal-measures, Shropshire. (Nat. size.)

breathing air directly. There are only four pairs of ambulatory legs, and none attached to the abdomen; they have no antennæ.

Of the spiders (Araneidæ), three are known from the Coal-measures, namely, the *Protolycosa anthracophila*, Römer, from Silesia, the *Arthrolycosa antiqua*, Harger, from Illinois, and an *Aranea* from the Coal of Bohemia. Spiders occur in the Tertiary rocks in great abundance, and examples may be seen from the Isle of Wight, from Baltic Amber, from the Miocene of Œningen, from Bonn, etc. One of the most interesting forms from the Coal-measures, belonging to the family Eophrynoidea, is the *Eophrynus Prestvicii*, Buckl., sp., which is preserved in a clay-ironstone nodule from near Dudley, and exhibits both upper and under surfaces of the same specimen. (See Fig. 116.)

GALLERY VIII. East Side. Wall-case 12, Table-case 85.

Scorpions.—In the Scorpionidæ, the head-shield is of moderate size, having a pair of larger ocelli, or simple eyes, near the centre

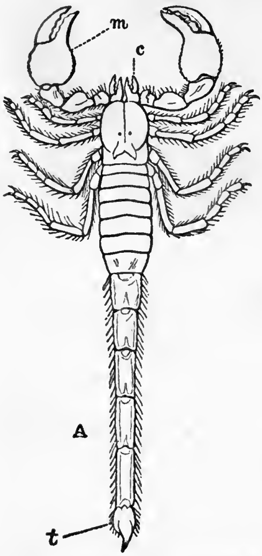



Fig. 117.—*Scorpio afer*, Linn. Recent: Africa. *m*, maxillary palpi; *c*, cheliceræ; *t*, the telson. (Reduced in size.)

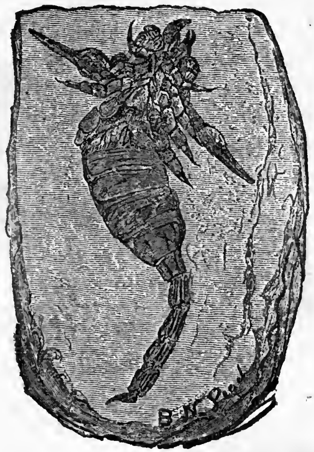


Fig. 118.—*Palæophoneus*, sp. Upper Silurian: Lesmahagow, Lanarkshire. (× $\frac{2}{1}$.)

Fig. 119.—*Eoscorpius carbonarius*, Meek and Worthen. Carboniferous: Illinois. (Nat. size.) (After Nicholson's Palæontology).

**GALLERY VIII. East Side. Wall-case 12, Table-case 85.**

of the shield, and a row of smaller ones near the front margin. There are no antennæ, but a pair of cheliceræ on the front of the head, followed by two large clawed limbs (maxillary palpi); behind these are the four pairs of walking-legs. The seven thoracic segments behind the head are broader than the rest of the body, and carry upon their under-side the posterior legs, the so-called combs, and the generative organs, and four pairs of stigmata opening into lung-sacs. The abdomen consists of six narrow, elongated segments, without appendages; the terminal one having a recurved poison-spine at its extremity (Fig. 117, *t*).

The scorpions are a very ancient tribe of air-breathers, having been met with fossil as far back in time as the Upper Silurian in Scotland, Gothland, and North America; they are also represented in the Coal-measures of England, Scotland, and Bohemia. (See Table-case 85 and Wall-case 12.)

## IV.—CRUSTACEA.

This class, represented by the Crab and Lobster and a great variety of other crust-clad animals with jointed limbs, is essentially fitted to inhabit the water, breathing by means of branchiæ, or gills. The entire body is usually encased in a hard structure, quite different, however, from the shell of the whelk or the oyster. This defensive envelope protects the softer parts of the body, and also covers the limbs, affording by its overlappings, infoldings, and projections, points of internal attachment for the muscles which move the legs and other organs of the animal. A cursory examination of a lobster, prawn, or shrimp, will show that, like the insects, the body-covering is made up of a number of rings or segments jointed together, to which the feelers, claws, and legs are united by means of movable sockets. To give greater protection to the soft parts of the body, it often occurs that several of these body-rings are soldered together into one piece, as in the crab and lobster; but as all these animals have one pair of jointed limbs to each ring or segment of their bodies, if we find a portion like the lobster's head-shield (called the cephalothorax), which has several pairs of limbs attached to it, we know that this part of the animal is composed of several separate rings or segments united together.

There are some Crustacea (e.g. *Squilla, Talitrus*) in which the separate rings can nearly all be seen and counted. In the higher forms, known as the Malacostraca, there are usually thirteen

segments referred to the head and thorax (cephalothorax), whilst the remaining six belong to the hinder part of the body called the abdomen (or *pleon*). Owing to the hard external covering possessed by nearly all the class, and to the fact that they mostly lead an aquatic existence, they are very abundantly represented in a fossil state in many geological deposits.

**GALLERY VIII. East Side. Wall-cases 13 & 14, Table-cases 80-85.**

(I) Entomostraca.—In the older formations in which Crustacea are met with, they all belong to the section Entomostraca, in which the body-segments are usually indefinite in number, and the limbs are very varied in character, the most important being attached to the head, the bases of the limbs serving also as mouth-organs.

1.—Ostracoda. In the Ostracoda the entire body is enclosed in a shelly carapace, composed of two valves united along the back

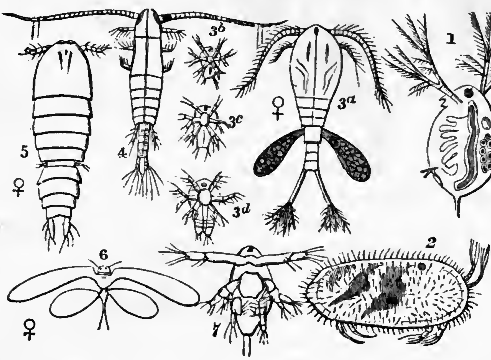



Fig. 120.—Small bivalved forms of Crustacea: Cladocera, Ostracoda, and Copepoda.

*1. Daphnia pulex*, Linn. *2. Candona hispida*, Baird.
*3. Cyclops quadricornis*, Linn. *a*, an adult female; *b, c, d*, larval stages.
Figs. *1, 2*, and *3* are all fresh-water forms.
*4. Cetochilus septentrionalis*, Goodsir. Firth of Forth.
*5. Sapphirina ovatolanceolata*, Dana. Atlantic.
*6. Nicothoe Astaci*, Aud. and Edw., parasitic, found on gills of the lobster.
*7. Nauplius* stage of a Copepod.

by a membrane; the valves can be closed or opened at will, and the appendages, with which the animal can either creep or swim, are protruded from the lower border. These small crustaceans first appear in the Lower Cambrian; they are met with subsequently in rocks of almost all ages, and are equally abundant living to-day both in seas and lakes. They must be looked upon as one of those

**GALLERY VIII. East Side. Wall-cases 12–14, Table-cases 80–85.**

persistent types which possess enormous powers of multiplication, so that entire beds of rocks may be said to be composed of their microscopic shelly coverings. The living species are known also to possess exceptional powers of endurance, and have special provision for the preservation of their lives in periods of drought; the eggs retaining their vitality in a dormant state for years.

Representatives of these, as *Leperditia*, *Beyrichia*, *Bairdia*, *Aristozoe*, *Carbonia*, *Candona*, *Cypridea*, *Cythere*, *Cypris*, *Primitia*, and many others, may be seen in the table- and wall-cases; they occur in rocks of nearly every age.

2.—Copepoda. In the order Copepoda are placed numerous small crustaceans, met with in incredible numbers both in fresh and salt water. The fresh-water *Cyclops* (Fig. 120, *3*), for example, is very abundant in ponds and rain-water tanks; and the *Cetochilus* (Fig. 120, *4*), although so minute, colours the sea with a reddish hue for miles, and furnishes by its vast numbers abundant food for so large a mammal as the "right whale." They have not been detected fossil in any of the rocks. In the Cladocera the head and *antennæ* project, but the rest of the body is entirely enclosed within a bivalved carapace; the antennæ are large and branching, and serve as swimming-organs. *Daphnia pulex* (Fig. 120, *1*), "the fresh-water flea," is a good example. It occurs in vast numbers in fresh-water ponds, but is not known in a fossil state.

3.—The Phyllopoda are Entomostracous Crustaceans having a shell composed of two valves in which the body is more or less completely enclosed, or it may form a buckler-like shield over the forepart of the animal. The gills are attached to the feet. Those living at the present day are found inhabiting both fresh water and the sea, and are of small size. *Protocaris Marshii* occurs in the Lower Cambrian of North America, and resembles the modern *Lepidurus* and *Apus* (Fig. 121, *3*, *4*). The living *Branchipus* (Fig. 121, *5*), or *Cheirocephalus*, and *Artemia* are unprotected by any shelly covering; but a fossil *Branchipus*, named *Branchipodites vectensis*, has been discovered in the Eocene of the Isle of Wight (Table-case 85). Species of the genus *Estheria* are met with in the Devonian and Carboniferous, and in all the subsequent formations even to the recent seas where it is now living.

4.—The order Phyllocarida was founded to include the living genus *Nebalia* (see Fig. 121, *2*), with certain extinct forms believed to be related to it, and which are considered to occupy an

intermediate position between the PHYLLOPODA and the higher MALACOSTRACA (such as *Mysis* and *Dyastylis*), though they certainly appear to be more nearly related to the former (the Phyllopods). The living *Nebalia* is a small marine crustacean, but the giant pod-shrimps, such as *Ceratiocaris Ludensis*, from the Silurian of Ludlow, attained a length of 2 feet. Other Palæozoic examples are *Isoxys Chilhoweana* (Walcott), from the Lower Cambrian; *Hymenocaris vermicauda*, from the Upper Cambrian; and *Ceratiocaris papilio* (see Fig. 121, *1*), from the Upper Silurian of Lanark. There are also *Dithyrocaris*, *Aptychopsis*, and many other genera ranging from the Cambrian to the Carboniferous period; they have not been met with in later rocks. **GALLERY VIII. Wall-cases 12–14, Table cases 80–85.**

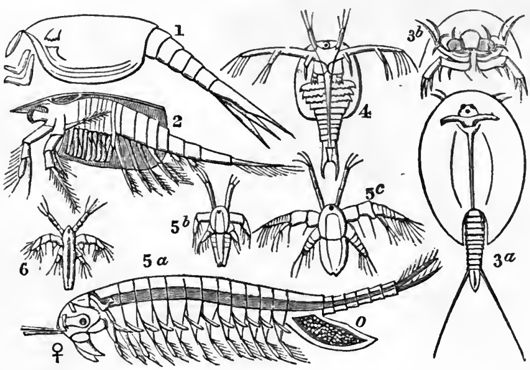



FIG. 121.—Entomostracous Crustacea.

PHYLLOCARIDA.

*1.* *Ceratiocaris papilio*, Salter. Upper Silurian: Lesmahagow. ($\frac{1}{12}$ nat. size.)
*2.* *Nebalia bipes*, Fabr. (living); half of carapace removed to show the body and appendages.

PHYLLOPODA.

*3.* *Lepidurus Angasii*, Baird. *a*, dorsal aspect (adult); *b*, ventral aspect.
*4.* Larva of *Apus cancriformis*, Schæffer.
*5.* *Branchipus* (*Cheirocephalus*) *stagnalis*, Milne-Edw. *a*, adult female; *b*, *c*, larvæ.
*6.* Larva of *Artemia salina*, Leach.

5.—TRILOBITA. The Trilobites form a very large but extinct order of ENTOMOSTRACA, the exact position of which was for a long time a matter of doubt, as no appendages had ever been found with any of them. By the recent discoveries made in North America,[1]

[1] E. Billings in 1870; C. D. Walcott in 1881; W. D. Matthew in 1893; C. E. Beecher in 1894.

**GALLERY VIII. East Side. Wall-cases 13 & 14, Table-cases 80–82.**

we now have a very complete knowledge of *Triarthrus Becki*, from the Ordovician formation of Rome, New York, and a more or less complete knowledge of *Asaphus, Calymene, Ceraurus, Trinucleus*, etc. The first pair of antennæ have a simple, many-jointed lash (or *flagellum*) attached to the under-side of the head on each side of the upper lip (*hypostome*). The second pair of antennæ have two branches, and the basal joint is triangular in shape and bears a masticating edge. The third pair of limbs are also biramous and correspond with the second pair, and may be compared with the mandibles of other Crustacea, being mouth-organs at their base. Two pairs of gnathites, or *maxillæ*, follow;

(1) (a) (2)

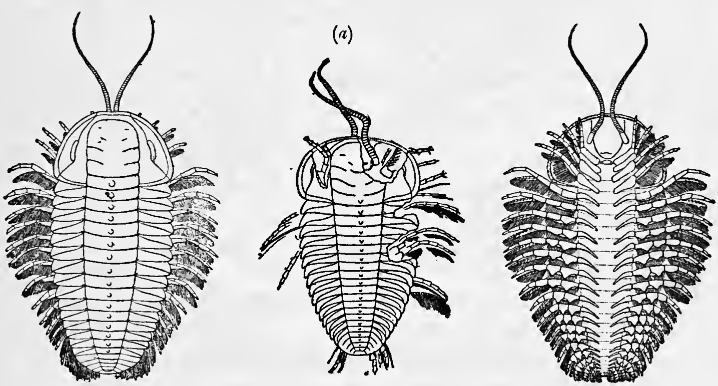


FIG. 122.—*Triarthrus Becki*, Green. Utica Slate (Ordovician): Rome, New York.

(*a*) Original specimen figured by Walcott.
(1) Upper and (2) under side (restored by Dr. C. E. Beecher).

they resemble the second and third pairs, but are somewhat larger; they all are used as mouth-organs, assisting in mastication. Behind them is placed a small oval metastoma, or lower lip. Fourteen pairs of biramous legs follow, each limb having a seven-jointed walking-leg (the *endopodite*) and a swimming-branch fringed with hairs (the *exopodite*) attached to its base. The anterior legs are the longest, the others very gradually becoming shorter towards the pygidium. The pygidium carries six pairs of appendages, each of which is also biramous, but the joints are transversely expanded so as to form broad lamellæ which probably assist in respiration,

also as swimmerets, and in the female to support the eggs. In many respects the Trilobites are very near in structure to the modern *Apus*. **GALLERY VIII. East Side.**

The great variability in the number of segments in *Trilobites* had long ago led to the conclusion that they were phyllopods; a knowledge of the simple biramose character of their limbs, as well as the gradual diminution in the size of the segments, and their appendages, from the head to the pygidium (a feature which **Wall-cases 13 & 14, Table-cases 80–82.**

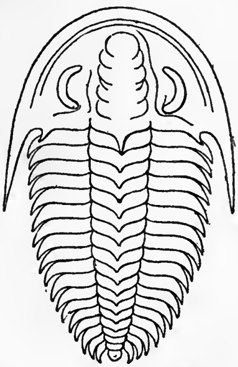


FIG. 123.—*Olenellus Callavei*, Lapw. Lower Cambrian: Shropshire.

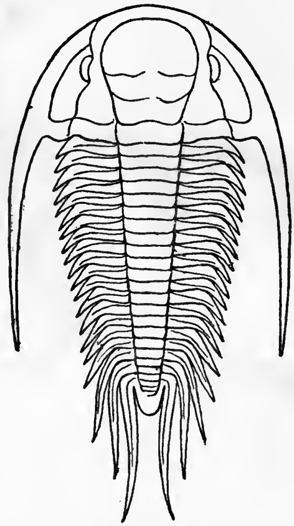


FIG. 124.—*Paradoxides Davidis*, Salter. M. Cambrian: St. Davids.

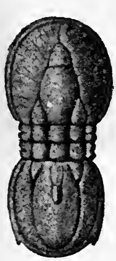


FIG. 125 —*Agnostus princeps*, Salter. Cambrian: S. Wales.

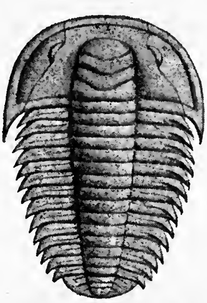


FIG. 126.—*Olenus*. Upper Cambrian.

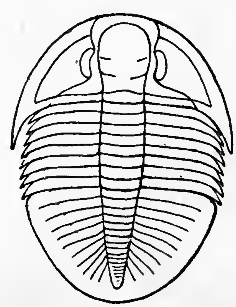


FIG. 127.—*Ogygia Buchii*, Brong. Ordovician: Llandeilo.

**GALLERY VIII. East Side. Wall-cases 13 & 14, Table-cases 80–82.**

the Trilobites share with *Apus*), entirely confirms this conclusion. Probably two thousand species and over one hundred genera of Trilobites are known from Palæozoic rocks. They first appear in the Lower Cambrian, attain their maximum development in the Silurian; about four genera continue on into the Carboniferous period, after which they entirely disappear.

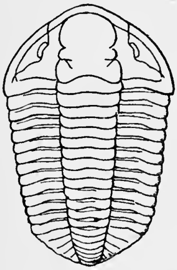


Fig. 128.—*Calymene Blumenbachii*, Brong. Upper Silurian: Dudley.

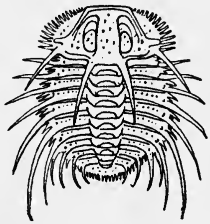


Fig. 129.—*Acidaspis mira*, Beyr. Upper Silurian: Dudley.

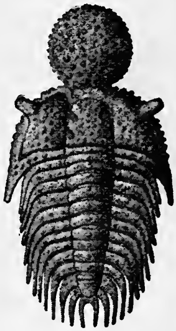


Fig. 130.—*Staurocephalus Murchisoni*, Barr. Upper Silurian: Dudley.

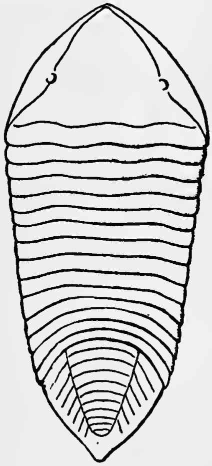


Fig. 131.—*Homalonotus delphinocephalus*, Green. Upper Silurian: Dudley.

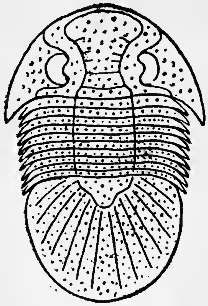


Fig. 132.—*Bronteus flabellifer*, Goldf. Devonian: Newton, Devon.

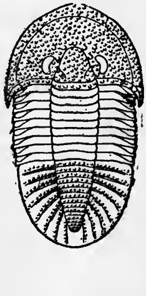


Fig. 133.—*Brachymetopus Ouralicus*, Portl. Carboniferous Limestone: Settle, Yorkshire.

(II) Merostomata.—Immediately following the Entomostraca are the Merostomata, a very remarkable group of Crustacea, some of which are of gigantic size. The mouth is furnished with mandibles

**GALLERY VIII.**

**Wall-cases 13 & 14, Table-cases 80–82.**

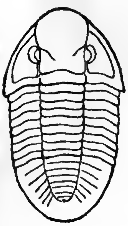


Fig. 134.—*Griffithides globiceps*, Portl. Carboniferous Limestone: Ireland.

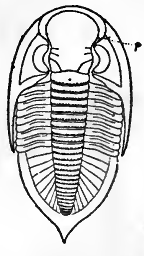


Fig. 135.—*Phillipsia Eichwaldi* var. *mucronata*, M'Coy. Carboniferous Limestone shale: Muirkirk.

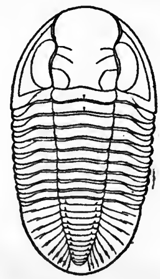
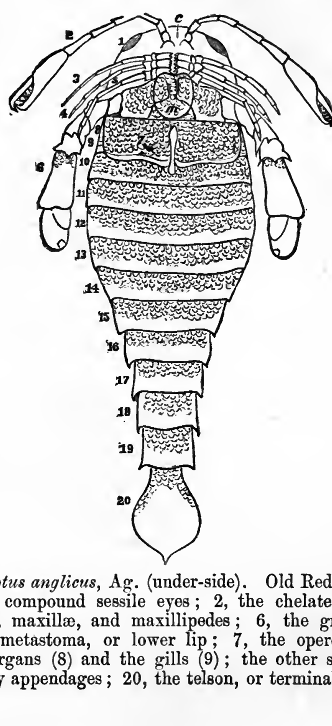


Fig. 136.—*Phillipsia Derbiensis*, Martin. Carboniferous Limestone: Derbyshire.



**Wall-cases 13 & 14, Table-cases 80 & 82, and Gallery-walls between Wall-cases 12 & 13, and 13 & 14.**

Fig. 137.—*Pterygotus anglicus*, Ag. (under-side). Old Red Sandstone: Forfarshire. 1, the compound sessile eyes; 2, the chelate antennæ; 3, 4, 5, the mandibles, maxillæ, and maxillipedes; 6, the great swimming jaw-feet; *m*, the metastoma, or lower lip; 7, the operculum, covering the reproductive organs (8) and the gills (9); the other segments (10–19) are destitute of any appendages; 20, the telson, or terminal segment.

**Crustacea.**
**GALLERY VIII.**
**East Side.**
**Wall-cases 13 & 14, Table-cases 80–82.**

and maxillæ, the terminations of which become walking or swimming legs, or organs of prehension. The Merostomata include two orders, namely, the Eurypterida and the Xiphosura (king-crabs). These are all aquatic, the former being extinct, whilst the latter (the king-crabs) are still living.

1.—The Eurypterida have an elongated flattened form, the body tapering towards the tail and having a peculiar scale-like ornamentation upon its hard covering. The head-shield bears a pair of compound eyes, and two minute ocelli on its upper surface, and covers only the mouth with its large lower lip (*metastoma*) and five pairs of jaw-feet, which are also the only

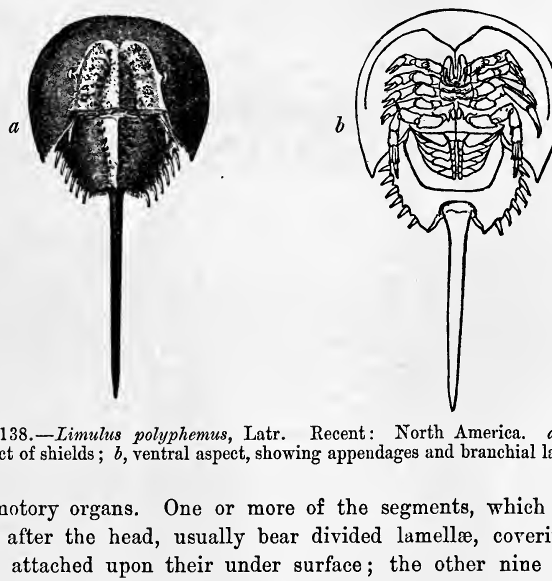



Fig. 138.—*Limulus polyphemus*, Latr. Recent: North America. *a*, dorsal aspect of shields; *b*, ventral aspect, showing appendages and branchial lamellæ.

locomotory organs. One or more of the segments, which follow next after the head, usually bear divided lamellæ, covering the gills, attached upon their under surface; the other nine or ten segments are without any appendages; and the body terminates in a spine-like or paddle-shaped telson (Fig. 137). The Eurypterida —represented by *Pterygotus*, *Slimonia*, *Eurypterus*, *Stylonurus*, *Hemiaspis*, etc.—appear first in the Silurian (Upper Llandovery), and are represented in the succeeding Devonian rocks, and on into the Lower Carboniferous epoch. The largest forms have been met with in the Old Red Sandstone of Forfarshire, some attaining nearly six feet in length. (See Table-case 80 and Wall-cases 13, 14.)

2.—In the XIPHOSURA (king-crabs) the head-shield forms a large semicircular buckler (Fig. 138*a*), bearing a pair of compound eyes and two minute ocelli upon its upper surface, and covering beneath its convexity (Fig. 138*b*) the mouth with its rudimentary lower lip (*metastoma*) and six pairs of feet, all but the first of which act as masticatory organs at their bases, and are also the only locomotory organs. The body-segments in living king-crabs are fused together, and carry six leaf-like plates upon their under-side, each bearing the branchiæ or gills attached to their inner surface. In the larval king-crab, and in some fossil species, these posterior segments of the body were freely articulated, not soldered together into one piece. The last segment of the body forms a long, sword-like, movable telson, or tail-spine. King-crabs first appear in the Upper Silurian; they are found in the Carboniferous period, in the Oolitic, Cretaceous, and Tertiary periods, and living on the coasts of America and China at the present day. (See Table-case 80 and Wall-case 13.)

**Crustacea. GALLERY VIII. East Side. Wall-cases 13 & 14, Table-cases 80–82.**

(III) ANCHORACEPHALA. — This section includes the RHIZOCEPHALA and the CIRRIPEDIA. The RHIZOCEPHALA and CIRRIPEDIA have free-swimming larvæ, resembling ordinary bivalved Entomostraca; but the former, when adult, have no mouth, lose all their limbs, and attach themselves by root-like processes to some living Crustacean, upon the juices of which they subsist; the latter attach themselves, when adult, to rocks, shells, drift-wood, ships, etc., and develop a peculiar multivalve shell, either fixed upon a stalk (pedunculated, *Lepadidæ*)—"Barnacles"—or attached directly to the stone or wood by the surface of their own shell (sessile, *Balanidæ*) —"Acorn-shells." These animals possess long cirri, which they protrude from their shell, and by the constant movements which they keep up convey in a current the food-particles to their mouth within the valves of their shell. The Rhizocephala are not found fossil; but the remains of Cirripedia occur both in Secondary and Tertiary strata, and have been admirably described by Charles Darwin. One form referred to the Cirripedia, named *Turrilepas*, has been met with in the Upper Silurian of Dudley, etc.

**Cirripedes, Balanidæ, and Lepadidæ.**

**Table-case 85, Wall-case 12c.**

(IV) MALACOSTRACA.—Passing from the ENTOMOSTRACA and their allies, to which *nearly the whole* of the older fossil forms of Crustacea belong, we arrive at the MALACOSTRACA, the next and higher division.

**Crustacea. GALLERY VIII. East Side. Table-cases 83 & 84.**

In these the head and trunk (cephalothorax) is composed of thirteen segments; the abdomen (or pleon) of six segments and a "telson" or tail-spine. The Malacostraca are divided into two orders—(1) the EDRIOPHTHALMA, in which the eyes are sessile or fixed on the surface of the head, and the head and thorax are distinct; and (2) the PODOPHTHALMA, in which the eyes are movable, being fixed on a peduncle or stalk (hence called "stalk-eyed Crustacea"), and the head and thorax are generally united to form a cephalothorax.

(A) EDRIOPHTHALMA: 1.—AMPHIPODA. The animals of this division are small in size; the body is compressed laterally. They are mostly found in the sea, or on its shores, where they abound. The common "sand-hopper" is a good example. One form, named *Necrogammarus Salweyi*, occurs in the Lower Ludlow, Shropshire; *Gampsonyx fimbriatus* in the Coal-measures of Rhenish Prussia; and *Prosoponisous problematicus* in the Permian of Durham. Various Tertiary Amphipods have been described.

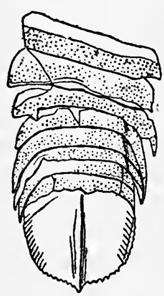


FIG. 139.
*Palæga Carteri*, H. Woodward.
Grey Chalk: Dover.

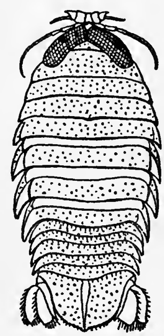


FIG. 140.
*Æga monophthalma*, Johnston.
Recent: Moray Firth.

2.—ISOPODA. The Isopods have seven pairs of walking-legs on the seven thoracic segments, which never bear gills; these are always attached to the appendages of the pleon or abdomen. *Prearcturus gigas* occurs in the Old Red (Devonian) of Hereford; *Bostrichopus antiquus* in the Devonian of Nassau. True Isopods are known from the Jurassic rocks (*Cyclosphæroma trilobatum*), Northampton, and from Solenhofen; *Archæoniscus Brodiei*, from the Purbeck of Wilts and Dorset. A parasitic form (*Bopyrus*) occurs fossil under the carapace of *Palæocorystes*, from the Greensand

of Cambridge. Several forms occur fossil in the Chalk and Tertiaries; as *Palæga Carteri*, Grey Chalk, Dover (Fig. 139), and *Eosphæroma Smithii*, Eocene, Isle of Wight.

**Crustacea. GALLERY VIII. East Side. Wall-cases 12–14, Table-cases 80–85.**

3.—Cumacea. The only fossil forms referable to this division are the so-called *Ceratiocaris scorpioides* and *C. elongatus* of Peach, from the Lower Carboniferous rocks of Scotland. The Cumacea have either no eyes or a single eye, whilst a very few have two eyes. They have a small cephalic shield, and a long slender body, with two forked swimming-feet at its extremity. Only the first five segments behind the head carry any appendages; the other segments have none. The feet all have two branches (an exopodite and an endopodite) like larval Crustacea, and also most Entomostraca.

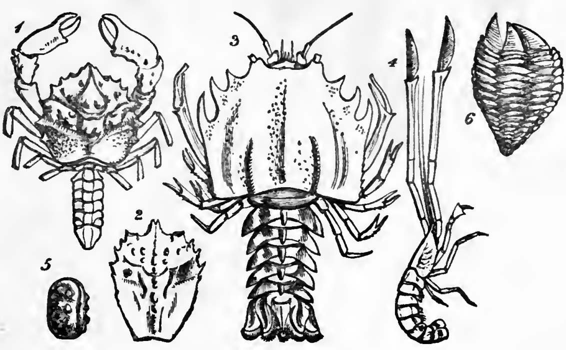



Fig. 141.

*1. Dromilites Lamarckii*, Desm. London Clay: Sheppey.
*2. Palæocorystes Stokesii*, Mant Gault: Folkestone.
*3. Eryon arctiformis*, Schl. Kimeridgian: Solenhofen.
*4. Mecochirus longimanus*, Schl. Kimeridgian: Solenhofen.
*5. Cypridea tuberculata*, Sby. Wealden: Sussex.
*6. Loricula pulchella*, G. B. Sby. Lower Chalk: Sussex.

(b) Podophthalma: 1.—Stomatopoda. This type of Crustaceans is one in which the divisions of the body can be very well and distinctly seen. The eyes are stalked; the carapace is very small; the antennules are branched; the antennæ carry a scale at their base. The second maxillipeds are developed into powerful raptorial organs, having comb-like claws. The free segments

**Crustacea.**
**GALLERY VIII.**
**East Side.**
**Wall-cases 12–14,**
**Table-cases 80–85.**

behind the head are narrow and small, but broaden out backwards to the tail-plate, which is wide and fan-shaped.

A fossil *Squilla, Necroscilla Wilsoni,* occurs in the Middle Coal-measures of Derbyshire; *Pygocephalus Cooperi,* from the Carboniferous of Glasgow, may also belong to this division. True *Squillas* occur in the Lithographic Stone of Solenhofen and in the Cretaceous of the Lebanon (see wall-case); and *Squilla Wetherelli* is found in the London Clay of Highgate (see Table-case 85).

2.—Schizopoda. This division is represented to-day by forms like *Mysis,* the "opossum-shrimp," characterized by the thoracic

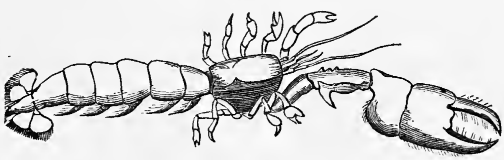


Fig. 142.—*Callianassa subterranea,* Leach. (Living species.)

feet being all "cleft-footed"; that is, having the exopodite and endopodite present in each limb, a characteristic feature of the adult Entomostraca, and of the larval state of many of the Malacostraca.

The cephalothoracic shield is smaller than in the true shrimps, so that the gills are often left exposed on the bases of the thoracic

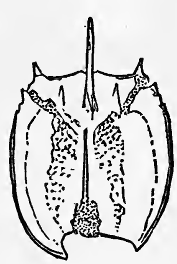


Fig. 143.—Carapace of an *Anthrapalæmon.* Coal-measures: Staffordshire.

legs. Some of the small Crustacea met with in the Coal-measures, such as *Palæocrangon socialis* (Salter) from Fifeshire, probably belong to this division. *Udorella Agassizii,* from the Lithographic Stone, Solenhofen, is also a Mysiform crustacean.

3.—MACROURA. To this section belongs the Lobster, Prawn, and Shrimp, with their numerous allies. They have stalked eyes; the cephalothorax bears five pairs of walking-legs; they have a well-developed pleon or abdomen, ending in a broad tail-fan for swimming; the branchiæ are placed beneath the overarching cephalothorax at the bases of the walking-legs. The oldest known member of this division is the *Palæopalæmon Newberryi* from the Upper Devonian of Ohio, U.S. Other early forms are met with in the Coal-measures, as the *Anthrapalæmon Russellianus*, *A. Parkii*, *A. Traquairii*, *A. Etheridgei* (Fig. 143). Another characteristic group is that of the *Eryonidæ*, abundantly represented from the Trias of Bohemia to the Neocomian of Silesia. Several allied genera were discovered living in deep water and dredged by the "Challenger" Expedition in the Mediterranean, Atlantic, and Pacific, from 220 to 1,900 fathoms. The recent species closely resemble their Oolitic and Liassic ancestors. (See Fig. 141, *3*.)

**Crustacea. GALLERY VIII. East Side. Wall-cases 12–14, Table-cases 80–85.**

The genera *Æger*, *Penæus*, etc., were well represented in the Jurassic rocks, and *Callianassa* from the Oolites to the Tertiaries. (See Fig. 142.)

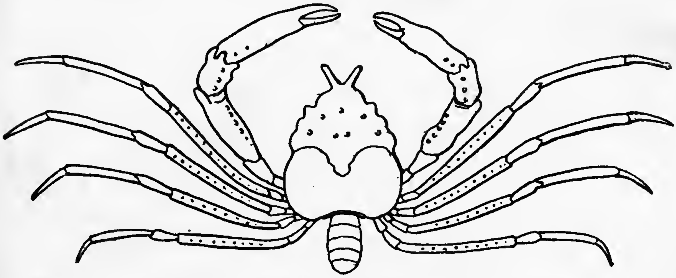


FIG. 144.—*Palæinachus longipes*, H. Woodw. Great Oolite: Wiltshire.

4.—BRACHYURA. This division embraces the "short-tailed" crabs, in which the abdomen is usually quite small and entirely hidden beneath the expanded carapace or cephalothorax; only in certain anomalous forms is the pleon, or abdomen, seen to project behind the cephalothorax.

True crabs first make their appearance in the Great Oolite, the oldest known crab being the *Palæinachus longipes* (H. Woodw.), from Wiltshire, which has the limbs also preserved (Fig. 144). Numerous small carapaces referred to the genus *Prosopon* occur in the Upper White Jura of Germany, and one in the Stonesfield Slate.

**Crabs.** **GALLERY VIII. East Side. Wall-cases 12–14, Table-cases 80–85.**

Many crabs are met with in the Cretaceous formation, represented by *Palæocorystes*, *Pliolophus*, *Ranina*, *Cyphonotus*, *Diaulax*, *Dromiopsis*, *Necrocarcinus*, *Orithopsis*, and many other genera.

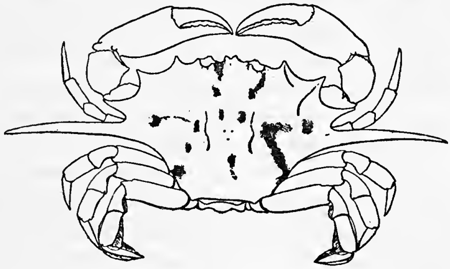


Fig. 145.—*Rhachiosoma bispinosa*, H. Woodw. Lower Eocene: Portsmouth.

In the Tertiary strata crabs are exceedingly abundant, being represented in the London Clay by the genera *Rhachiosoma*, *Plagiolophus*, *Litoricola*, *Necrozius*, *Xanthopsis*, *Xanthilites*, *Lobocarcinus*, and many more. (See Table-case 84 and Wall-case 12.)

## (Division B.—ANARTHROPODA.)

## V.—VERMES—WORMS.

**Vermes—Worms.** **GALLERY VIII. Table-case 79, Wall-case 15a.**

As the worms are all soft-bodied animals, they are comparatively seldom found in a fossil state. Their former existence is shown by the tracks, burrows, and castings which they have left in the wet mud and upon the ripple-marked sands of old seashores, before these had become hardened into shales and sandstones. More definite evidence is afforded by the small teeth which are present in some forms, and by the tubes in which some of them live. Such proofs of the former existence of worms are fairly abundant, but their identification is very difficult. The classification of existing worms is based entirely on the structure of the soft parts of the bodies; it is only very rarely that any trace of these is preserved in the fossils. The *Eunice* from the Pleistocene deposits of Greenland and the specimens of *Eunicites* from the Lithographic Stone of Solenhofen (in Wall-case 15a), are in as perfect a condition of preservation as soft-bodied worms can be expected to occur. Nevertheless, even in these cases, the genera cannot be determined with certainty.

**Wall-case 15a.**

Worms. GALLERY VIII. Wall-case 15a and Table-case 79.

It must therefore be remembered, when consulting the collection of fossil worms, that the names given to the specimens do not mean the same in palæontology as they do in zoology. Thus, zoologists use the names *Serpula* and *Ditrypa* for worms which are closely allied to one another, but differ in the structure of the thorax. Palæontologists, however, are unable to use this character, as no fossil specimen known of either genus retains any trace of this part of the body, and the genera are separated only by the character of the tube. The meaning of some other names, such as *Pomatoceras*, *Sabella*, and *Galeolaria*, also depends on whether they are used for recent or fossil specimens.

The tracks made by worms when walking over soft mud cannot be distinguished from those of some other animals and of plants, and the tracks are therefore all placed together in Wall-case 7 in Gallery XI. In spite of the elimination of these, it is probable that the specimens exhibited in the worm collection include remains of animals belonging to other groups. Some of the burrows (such as those in the Aymestry Limestone) were probably made by mollusca, and some others (such as *Talpina* from the Chalk) by sponges. Some of the tubes, moreover, such as the *Vermetus* from the London Clay and some species referred to *Ditrypa*, will probably have to be transferred to the Mollusca if the bodies be ever found. The famous *Spirorbis* from the Coal-measures of South Joggins, in Nova Scotia, is almost certainly a mollusc. (Fig. 148, p. 87.)

The fossil worms, therefore, are not a group which admit of much precision in identification and classification, although they are often of considerable value to the geologist as marking the age of rocks, and the conditions under which they were formed.

The Vermes are divided into several groups, of which, however, with some doubtful exceptions, only one is met with in the fossil state. This is the group Chætopoda, or worms bearing bristles, or "setæ." Of this group there are two divisions—the Oligochæta, the members of which have only a few "setæ"; and the Polychæta, in which the worms have bundles of bristles, attached to lateral appendages known as "parapodia." The Oligochæta are not certainly known as fossils, and the Polychæta therefore include practically all the fossil worms. The Polychæta are divided among two orders—the Errantia, or free-swimming worms; and the Tubicola, including

**GALLERY VIII. Wall-case 15a. Table-case 79.** those which dwell in tubes. The former order is represented in the collection by the *Eunice* from Greenland, and by a series of specimens from Solenhofen belonging to the genus *Eunicites.*


Fig. 146.—(A) Tubes of *Ortonia conica*, Nich., growing upon the valve of *Rafinesquina alternata* (nat. size). (B) A single tube of the same, enlarged. Ordovician.

**Table-case 79.** The British collection in Table-case 79 commences with some burrows in the famous "Basal Quartzites" of Cambrian age in Sutherland, which are called *Arenicolites,* as it is assumed that they were made by worms allied to the modern lob-worm, or *Arenicola.* There is, however, no proof that they were not made by plant roots. These are associated with some equally doubtful

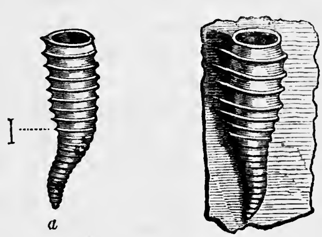



Fig. 147.—*Ortonia intermedia*, Nich. Devonian: Canada. *a*, one of the tubes. enlarged; *b*, another example, in which the rings are greatly extended laterally, enlarged.

forms referred to the genus *Serpulites,* of which better representatives occur in the Silurian. In this series the most interesting worms are some species which are generically indistinguishable

from the existing *Spirorbis*, and some remarkable clusters of ringed tubes known as *Cornulites*. **GALLERY VIII.**

The Carboniferous worms contain some tubes from Ireland which are referred to the genus *Serpula*, while the small coiled *Spirorbis* is represented by five species. *Serpula* is very common in the Jurassic, and includes both the typical adherent species and those in which the oral end of the tube is erect. A series of short, **Wall-case 15a, Table-case 79.**

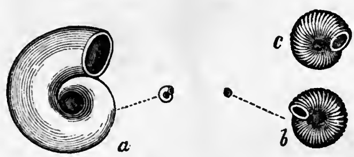


FIG. 148.—*a*, *Spirorbis omphalodes*, Goldf.; *b* and *c*, *Spirorbis Arkonensis*, Nich. Devonian: Arkona, Canada.

slightly curved, free tubes are referred to the genus *Ditrypa*, and some dense clusters to *Galeolaria*. The Cretaceous worms resemble in their general characters those of the preceding period, but three new types should be noticed. One is the *Terebella*? *Lewesiensis* (Mant.), represented by the tubes in which the worm lived; as these are composed mainly of fish-scales, they were originally described as fossil fishes. A second interesting form is one which burrowed into sponges. The third, known as *Talpina*, contains animals which drilled passages in the shells of sea-urchins and Belemnites, and which are probably sponges.

*Serpula heptagona*, Sby., from the Barton Beds, should be noticed, as the opercula are included in the collection, and thus the genus can be more accurately determined. The coiled tubes known as *Vermetus Bognoriensis*, Sby., of which two fine slabs are exhibited in the wall-case, may be either Annelidan or Molluscan.

Among the foreign worms in Wall-case 15A the *Eunice* from Greenland, the genus *Rotularia* from the Lower Tertiary, and the *Pyrgopolon* from the Cretaceous, the *Eunicites* showing the bristles and jaws from the Solenhofen Slate, and the coiled castings known as *Lumbricaria* from the same limestone, are most worthy of attention. **Wall-case 15a.**

## III.—ECHINODERMA.

**GALLERY VIII.**
**Wall-cases 15-18, Table cases 73–78 & 75a.**

The Starfish, the Sea-Urchin, the Brittle-Star, the Feather-Star, and the Sea-Cucumber, all of which live in modern seas, are examples of the subkingdom Echinoderma. Though differing from one another in outward appearance, they resemble one another and differ from the rest of the animal kingdom in the following characters.

The soft tissues of the animal have the power of depositing crystalline carbonate of lime. This may remain in the shape of minute separate spicules; or the spicules may grow together into a trellis-work, which forms rods and plates. The deposit is usually most abundant in the skin, where it may be built into a continuous skeleton, such as the test of the sea-urchins. Often, too, spines of the same carbonate of lime are borne outside the test. This feature, so characteristic of the sea-urchin, has given to the subkingdom the name Echinoderma (ἐχῖνος 'an urchin,' and δέρμα 'skin').

The next feature noticeable in an echinoderm is its radiate structure, in many cases giving the animal a star-shape, to which the common names starfish, brittle-star, and the like, are due. The number of rays is usually five. The radiate arrangement always affects the skin and test and the organs connected therewith; but it may also affect the internal organs. In a starfish, for instance, nearly all the organs of the body are arranged in a radiating manner around a central axis in such a way that the animal can be divided into five similar portions. This radiate symmetry must not be confused with that seen in the subkingdom Cœlentera (which includes corals and jelly-fish), since the Echinoderma differ from those animals in having, as in all higher subkingdoms, their digestive apparatus in the form of a *gut* entirely shut off from the main body-cavity, while a system of branched tubes or spaces carries *blood* through the body.

The third feature characteristic of the Echinoderma is a system of sacs, canals, and tubes, that carry *water* through the body. Small hollow processes, called podia, are given off from this system, and pass through holes in the test. These holes are arranged in five double rows, called avenues or ambulacra, which definitely mark the five rays of the animal. The processes may be retracted, or may be stretched out by the squeezing of water into them. Some of the processes, or podia, end in small sucker-like discs, which the animal can attach to smooth surrounding

objects, and so hold itself firm or pull itself along. Other podia end merely in a point, and serve only to aerate the contained fluid.

**GALLERY VIII. East Side. Wall-cases 15–18, Table-cases 73–78.**

The subkingdom Echinoderma is divided into seven classes, five of which have representatives in modern seas. A very slight examination of a sea-cucumber (Holothurian), a sea-urchin (Echinoid), a starfish (Asteroid), a brittle-star (Ophiuroid), and a feather-star (Crinoid), will show important differences between them. In an ordinary Holothurian (e.g. *Holothuria, Cucumaria*) the body is cucumber-shaped, with a mouth at one end and an anus at the other; between the mouth and anus run the five ambulacra, of which one or two are often more developed than the others, so that the animal crawls along on that side of its body, with its mouth foremost. A holothurian has no arms or projecting rays, but its mouth is surrounded by a circlet of tentacles, often branched, which can be retracted at will. A regular sea-urchin (e.g. *Echinus, Cidaris*) resembles a holothurian in being without projecting rays; but it is more spherical in shape, and moves with its mouth towards the sea-floor and with its anus at the opposite pole of the body. In a heart-urchin (e.g. *Spatangus*), which moves through and swallows mud and sand, the body has become transversely elongate—that is, the long axis is at right angles to the position it occupies in a holothurian; the mouth has moved a little forward, and the anus has moved down from the top of the body to its lower surface, so that both mouth and anus lie on the under surface, at either end of the long axis. In a starfish, as in a regular sea-urchin, the mouth is in the centre of the under surface, while the anus is almost in the centre of the upper surface, but is absent in a few forms; the body is either markedly pentagonal in outline, or it is more or less star-shaped, in which case it is said to consist of a central "disc" extended into "arms." The number of these arms varies from five (e.g. *Asterias rubens*) to over forty (e.g. *Heliaster*). A brittle-star resembles a starfish in which there is a sharp distinction between arms and disc; the mouth is on the under surface, but there is no anus. Moreover, whereas the "arms" of a starfish are merely extensions of the body, containing the generative glands and processes from the stomach; the arms of a brittle-star are appendages to the body, with a stout internal skeleton of separate ossicles, worked on one another by well-developed muscles, and they contain only blood-vessels, water-vessels, and nerves. The

Echinoderma. GALLERY VIII. East Side. Wall-cases 15-18, Table-cases 73-78.

arms of the brittle-stars are nearly always five in number, though *Ophiactis* and *Ophiacantha* sometimes have from six to eight. As in the starfish, the arms are unbranched, except in the Astrophytidæ, where they fork ten or twelve times, and where the numerous branches interlace so as to form a kind of basket-work all round the disc, whence these animals are called Basket-fish or Medusa-head Starfish. A crinoid differs markedly from a sea-urchin, starfish, or brittle-star, in that the mouth faces upwards, or away from the sea-floor; the anus is also on the upper surface. This position is due to the fact that, so far as we know, all crinoids are at some time of their lives attached by a stalk to the sea-floor or some other object, so that mouth and arms naturally move up to that side of the body furthest from the stalk. This fixed state of existence has also caused the development of arms, five in number, but often forked many times, which arms stretch out from the body on all sides of the mouth, and contain extensions of the nervous, blood-vascular, water-vascular, and generative systems.

## I.—Holothuroidea.

Holothurians. Table-case 78.

Sea-cucumbers are represented as fossils only by the spicules and minute plates formed in the skin. These are known from Carboniferous times. Spicules of *Cucumaria* from the Pliocene of St. Erth, Cornwall, and plates of *Psolus* from Scotch Glacial beds, are exhibited.

## II.—Echinoidea.

Echinoidea—Sea-urchins. Table-cases 76-78, Wall-cases 15-17.

This class contains those Echinoderma in which the body is completely surrounded by a "test," composed of closely-fitting calcareous plates arranged in zones, of which there are usually ten pairs. The mouth is always situated on the lower surface, but the anus may open either at the centre of the upper surface, opposite the mouth, on the margin, or on the same side as the mouth.

The test of the common "sea-urchin" found on the English shores (*Echinus esculentus*) is composed of twenty rows of plates placed in vertical series, together forming an almost spherical case. The plates are of two sizes: the smaller, or "ambulacral plates," each consist of three others, fused together so intimately, that the composite character of the plate can often only be recognized owing to the presence of three pairs of small pores.

The whole "test" is covered with tubercles on which, in the

living animal, are fixed strong pointed spines. In the centre of the upper surface is the aperture of the anus, surrounded by a double circle of plates (the "apical plates"), which have been regarded as equivalent to the radial and basal plates which form the most essential constituents of the cup of the crinoids. The mouth is a large opening on the lower surface; it is surrounded by a girdle of five arches, each formed of a pair of auricles, which supports an elaborate jaw-apparatus.

**Sea-urchins. GALLERY VIII. East Side. Wall-cases 15–17, Table-cases 76–78.**

Most of the recent Echinoidea are based on the same fundamental plan; but it is often obscured by great changes in shape. Thus, in the genus *Galerites*, though in all species the mouth is central, in some the anus opens on the margin of the test, and in others it is situated on the under surface. In other forms, such as the common *Echinocorys scutatus* (syn. *Ananchytes ovatus*) and the living "Heart-Urchin" (*Spatangus purpureus*), the mouth is pushed forward near the anterior margin. In most of the Echinoids, the spines are distributed fairly equally over the test, but in some cases special forms of spines occur along narrow bands known as "fascioles."

The test of an Echinoid therefore consists of the following elements: the double circle of "apical plates"; five pairs of rows of "ambulacral," and the same number of "interambulacral" or "interradial" plates; and in many forms also five pairs of "auricles" and five teeth with their sockets. All bear spines, some of which are modified into jaw-like claspers, "pedicellaria."

The British fossil sea-urchins occupy Table-cases 76–78, and the foreign Wall-cases 15–17.

The oldest known British Echinoids are three species from the Ludlow Series — *Echinocystites pomum*, *E. uva*, and *Palæodiscus ferox*. These, however, are in an unsatisfactory condition of preservation, and their structure is primitive. Specimens are exhibited in Table-case 76. There are few representatives of this class in the English Devonian, but a good series of species occur in the Carboniferous. Of these, *Palæechinus* is the best-known genus (Fig. 149). Like most of the Palæozoic forms, it has more than twenty zones of plates, there being three or more in the interradii. *Archæocidaris* is another interesting type, for the plates are somewhat overlapping, so that the test may have been flexible; the teeth (*e.g.* specimen 75,940) are constructed on the same type as those of the recent *Cidaris*. A polished slab of

Echi-
noidea.
GALLERY
VIII.
Wall-cases
15–17,
Table-
cases
76–78.

Carboniferous Limestone from Bristol (No. 75,724) shows that the spines were often of great length.

In the Jurassic system the Echinoidea become of great geological importance. The collection (Table-cases 76 and 77) includes most of the specimens figured by Wright in his monograph of the Oolitic Echinoderms, published by the Palæontographical Society. The successive faunas are of great interest, beginning with comparatively simple forms, such as the *Cidaris Edwardsi*, *Acrosalenia minuta*, and *Diademopsis Bowerbanki*, from the Lias. With the exception of the *Cidaris*, the species from this horizon are small, and apparently grew under somewhat unfavourable conditions. In the Lower Oolites, however, limestones become abundant, and the seas were more suited to sea-urchins. Many

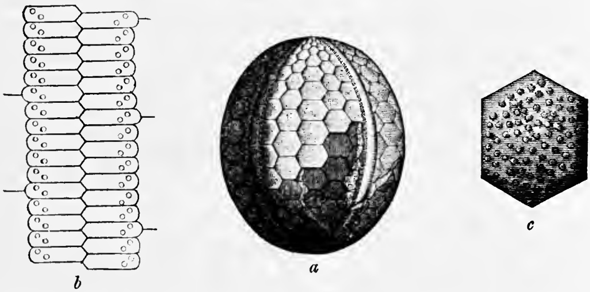



Fig. 149.—*Palæechinus ellipticus*, M'Coy. Carboniferous Limestone: Ireland.
*a*, side-view of the entire test.
*b*, portion of one of the ambulacral areas, enlarged.
*c*, a single hexagonal interambulacral plate.

new types therefore appear, and are represented by massive forms. The most characteristic genera in the Inferior Oolite are *Clypeus*, *Pygaster*, *Holectypus*, and *Stomechinus*. The most interesting genera are probably *Hyboclypeus*, *Galeropygus*, and *Collyrites*. The succeeding fauna in the upper part of the Lower Oolites has new species of some of these genera, while *Acrosalenia* and *Hemicidaris* (Fig. 150) become abundant. Some fine slabs of these are shown in Table-case 77, while still larger specimens are shown in Wall-cases 17A and 15B and C. In the Corallian the species are fewer, but of great interest. *Cidaris* is represented by two fine species—*C. Blumenbachi* and *C. florigemma*. The largest known *Hemipedina* is exhibited in Table-case 77, and close beside it is the prettily ornamented *Glypticus*

Table-
case 77,
Wall-cases
17a, 15b, c.

**Sea-urchins. GALLERY VIII. East Side. Wall-cases 15–17, Table-cases 76–78.**

*hieroglyphicus* and the specimens of *Pelanechinus*, which appears to have been flexible like the recent *Phormosoma*. Another existing deep-sea type is foreshadowed by the genus *Collyrites*, in which the apical system of plates is broken up, much as it is in *Pourtalesia*.

The Cretaceous Echinoidea contain two distinct faunas—one from the Lower Greensand, and one from the Gault, Upper Greensand, and Chalk. The former is small, but the latter is the most interesting in the English series. The most striking feature in it is the predominance of large specimens of *Cidaris*, of which a fine series of specimens from the Chalk is shown in Table-case 77. Amongst these, reference may especially be made to the example (E. 1,952) of *Cidaris sceptrifera*, with


Fig. 150.—*Hemicidaris intermedia*, Lamk., sp., showing tubercles, the larger of which are perforated and surrounded by an areola. Corallian Oolite: Calne, Wilts. (Natural size.)
*a*, side-view of test. *b*, test seen from above.

the apical plates, and those of *Cidaris clavigera* (33,455 and 39,998), which show the jaws in position and the spines attached. Following the family of the Cidaridæ comes that of the Saleniidæ, which is of interest as having an additional plate in the apical system.

The great family of the Diadematidæ is represented by a large series of forms, of which *Cyphosoma Koenigi*, from the Chalk, is the best known. The genera *Glyphocyphus* and *Zeuglopleurus* are of interest as the forerunners of sea-urchins with pitted tests, such as *Temnopleurus*.

The specimen in the Cretaceous series which is most worthy of notice is an *Echinothuria floris* (No. 40,376), which is the type of that genus and was the first Echinoid with imbricating scales described from rocks later in date than the Palæozoic.

Echinoidea.
GALLERY VIII.
East Side.
Wall-cases 15–17,
Table-cases 76–78.

It is a close ally of *Phormosoma* and *Asthenosoma*, two living genera which were subsequently found at great oceanic depths.

The remarkable perignathic girdle of Discoidea shown in a specimen (40,341) from the Chalk of Burham, resembles that of a small recent West Indian species. The type of *Pygurus lampas* (Beche), from the Upper Greensand of Lyme Regis, is of interest from its remarkable form, and its rarity, it being the only known specimen of the species.

The series of Echinoids belonging to the genera *Hagenovia* and *Infulaster* are worthy of attention owing to their abnormal forms;

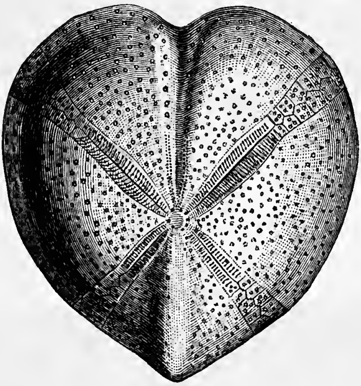


Fig. 151.—Upper surface of *Micraster cor-anguinum*, Leske. Upper Chalk: Bromley, Kent.

and the collection of specimens of *Echinocorys scutatus* (syn. *Ananchytes ovatus*) illustrates the varying forms that can be adopted by a single species.

The British Cainozoic Echinoidea are fewer in number and smaller in size than those of the Cretaceous and Jurassic periods. The Eocene series contain a few forms which in comparison with those which lived at the same period in Southern France are dwarfed and stunted. The Crag species are larger and more numerous. The most interesting species is *Temnechinus Woodi*, of which both the male and female forms are shown in the collection; the latter was originally described as *Temnechinus excavatus*. The presence of several sea-urchins of West Indian types, such as *Rhynchopygus Woodi*, *Agassizia equipetala*, and

*Echinolampas subrostrata*, in British seas at this period, is a significant fact in distribution, for it shows that the land barrier which formerly separated this region from the Southern Ocean had been breached.

**Sea-urchins. GALLERY VIII. East Side.**

**Wall-cases 15–17.**

The foreign sea-urchins are shown in Wall-cases 15–17. The Palæozoic collection is exhibited in the last. The American genus *Melonites* is represented by two fine specimens on the slope, and two groups in frames at the back of the case. The Jurassic fauna is on the floor of Wall-case 16: it includes the types of three French species of *Hemipedina*, and some large specimens of *Rhabdocidaris*. The Cretaceous species occupy the remainder of Wall-case 16, and part of the lowest shelf of 15c. A large specimen of *Hemipneustes striato-radiatus*, from Belgium, mounted on a block on the uppermost shelf in 15b, should not be overlooked, as it is the largest sea-urchin in the collection. Some species of *Clypeaster* are only a little smaller, and a fine series from the Cainozoic rocks of the Mediterranean Basin and the West Indies is shown in blocks in this wall-case. The Cainozoic Echinoids are the most important of the foreign collections, including a large series of the types of those from Malta and Australia. A large broken specimen from Barbados (*Cystechinus crassus*) is of interest, as it is the only fossil belonging to any of the higher groups that has as yet been found in the deep-sea, oceanic marls of Barbados.

## III.—Asteroidea.

**Asteroidea—Star-fishes.**

**Wall-cases 15 & 17, Table-cases 75, 75a, & 76.**

This class includes the common Starfish; but not the Brittle-

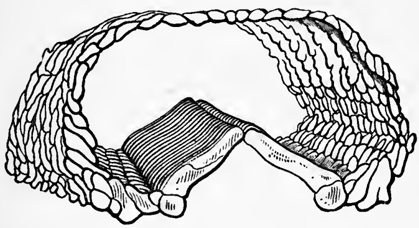


Fig. 152.—Section of a ray of a Starfish, *Uraster rubens*, Linn., sp., showing the arrangement of the calcareous ossicula.

Stars, which are Ophiuroidea, nor the Rosy-Feather Star, which is a crinoid. The starfishes differ from the sea-urchins by not

Asteroidea — Starfishes.
GALLERY VIII.
East Side.
Wall-cases 15 & 17,
Table-cases 75 & 76.

having a closed skeleton of regular, closely-fitting plates. The main skeleton consists of a series of plates on the under surface of the body; above, it is usually leathery and supported by rods arranged in an open meshwork. (Fig. 152.)

The oldest starfishes in the British collection are *Palæasterina Kinahani* and *Palæaster Caractaci*, both represented by casts in rocks from the Caradoc, or uppermost division of the Ordovician system. Specimens from the Wenlock Limestone are in better preservation, notably a fine example of *Lepidaster Grayi*, at the end of Table case 75.

The Jurassic collection contains some fine starfishes, notably *Asterias Gaveyi*, *Solaster Moretonis*, and a massive *Pentagonaster Sharpi*, from the Northampton Ironstone. Some large specimens

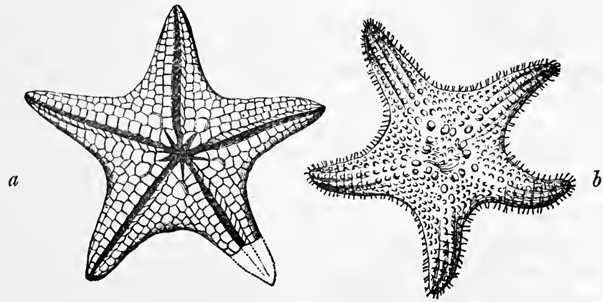


FIG. 153.
*a*, *Palæasterina stellata*, Billings (under surface). Ordovician (Trenton Limestone): Ottawa.
*b*, *Palæasterina primæva*, Forbes (upper surface). Upper Silurian: Kendal.

of species included in the comprehensive genus *Astropecten* are shown in Wall-case 17.

The Cretaceous collection contains specimens which are in even better preservation than those of the Jurassic; and it includes most of the types of the species described by Sladen in his monograph of the Cretaceous Asteroidea. The specimens especially worthy of note are those of *Calliderma Smithi*.

The Cainozoic fauna consists only of some species from the London Clay of Sheppey, many of which are in an imperfect condition of preservation.

The foreign starfishes are shown in Wall-case 17A. It contains some interesting forms from the French Jurassic, and a valuable

series of Palæozoic species from the Lower Devonian of Bundenbach, in Germany. An additional set of these is exhibited in a table-case in the middle of the gallery (75*a*). In this are shown the type-specimens of Stürtz's monograph on the fauna, published in 1890 in the "Palæontographica." As the fossils of this locality are altered into iron pyrites, they are hard in comparison with the slate in which they are imbedded, and thus they can be cleared from matrix and both sides of the specimen shown. In this collection attention may be especially directed to *Palæasteriscus Devonicus*, *Cheiroptaster giganteus*, and *Helianthaster Rhenanus*. **Starfishes. GALLERY VIII. East Side. Table-cases 75, 75a, & 76, Wall-cases 15 & 17.**

### IV.—Ophiuroidea.

The Brittle-Stars and Sand-Stars differ from the ordinary starfish by having arms sharply marked off from the central disc, **Ophiuroidea—Brittle-stars. Wall-case 17, Table-case 75.**

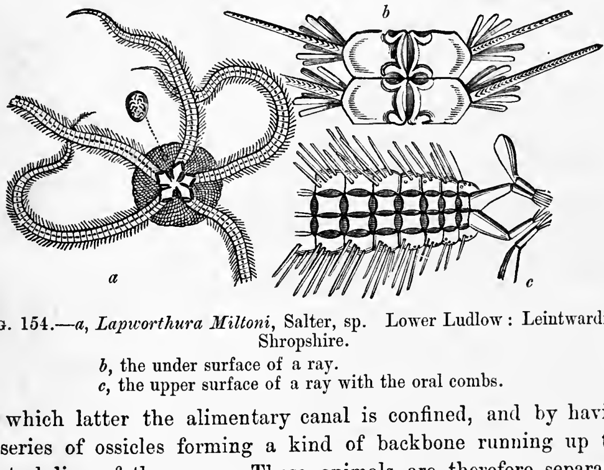



Fig. 154.—*a*, *Lapworthura Miltoni*, Salter, sp. Lower Ludlow: Leintwardine, Shropshire.
*b*, the under surface of a ray.
*c*, the upper surface of a ray with the oral combs.

to which latter the alimentary canal is confined, and by having a series of ossicles forming a kind of backbone running up the central line of the arms. These animals are therefore separated as a distinct class, the Ophiuroidea. The members of this class are of less value to the geologist than those of the Asteroidea, but the collection contains some interesting species.

One of the best-known forms in the English series is *Lapworthura Miltoni* (Fig. 154), from the Ludlow Shales, in some specimens of which (such as 46,753, and 57,425) the structure of the jaws and the ossicles in the arms can be determined. The genus *Eucladia* is represented by the type-specimen (*Eucladia Johnsoni*, H. Woodw.), and has the arms coiled like the recent *Euryale*.

**Ophiuroidea.**
**GALLERY VIII.**
**Table-case 75, Wall-case 17.**

In the Jurassic period there are some well-preserved brittle-stars referred to the genera *Ophioderma*, *Ophiolepis*, and *Ophiurella.* The collection includes many of the types described by Wright, and also the specimens of *Ophioglypha serrata*, from the Chalk, figured by Dixon. *Ophioglypha Wetherelli*, from the London Clay, is the most important of the British Cainozoic brittle-stars, while the Pleistocene deposits of Western Scotland have yielded a species, *Ophiolepis gracilis*, Allm., which is well represented by three specimens (40,220).

The foreign Ophiuroids are on the lowest shelf of Wall-case 17A. In the Mesozoic series the four best forms are *Geocoma Libanotica* from the Cretaceous limestones of the Lebanon, *Geocoma carinata* and *Ophiurella speciosa* from the Solenhofen Slates, and a small *Hemiglypha* from the Muschelkalk.

The Palæozoic fauna is represented by species of *Protaster* and *Onychaster flexilis*, M. and W., from the Carboniferous rocks of Indiana, the latter of which has coiled arms like the *Eucladia.* The most valuable series is, however, that from the Devonian Slates of Bundenbach, in Germany, including Stürtz's type-specimens, which are shown in a table-case in the middle of the gallery. The species of *Ophiurina* and *Eoluidia* are the most instructive.

## V.—Crinoidea.

**Crinoidea.**
**Table-cases 73 & 74, Wall-cases 16–18.**

This class is represented in modern seas, at all depths, by six genera with stalks (e.g. *Pentacrinus*, *Rhizocrinus*) and six without (e.g. *Antedon*): the forms named are exhibited for comparison with the fossils. Whether stalked or unstalked, the crinoid has a calyx of varying size, in which its viscera are packed, and five flexible arms, which are often much branched and often provided with small side-branches or pinnules. The stalk and fern-like arms give these animals a very plant-like aspect; hence the name crinoid, meaning "lily-form." The mouth is placed on the top of the calyx, between the arms. Each arm is grooved on its inner surface, and water containing the animalculæ on which the crinoid feeds is swept down the grooves to the mouth. The nutritive stream passes through the gut coiled inside the calyx, and out again at the anus, which is often at the end of a long tube (e.g. *Actinocrinus*). Further details as to the structure of a crinoid are explained in Table-case 73. The

accompanying figure is reconstructed from the evidence of actual specimens of the Silurian crinoid *Botryocrinus decadactylus*, all of

**Crinoidea. GALLERY VIII. East Side. Table-case 73.**

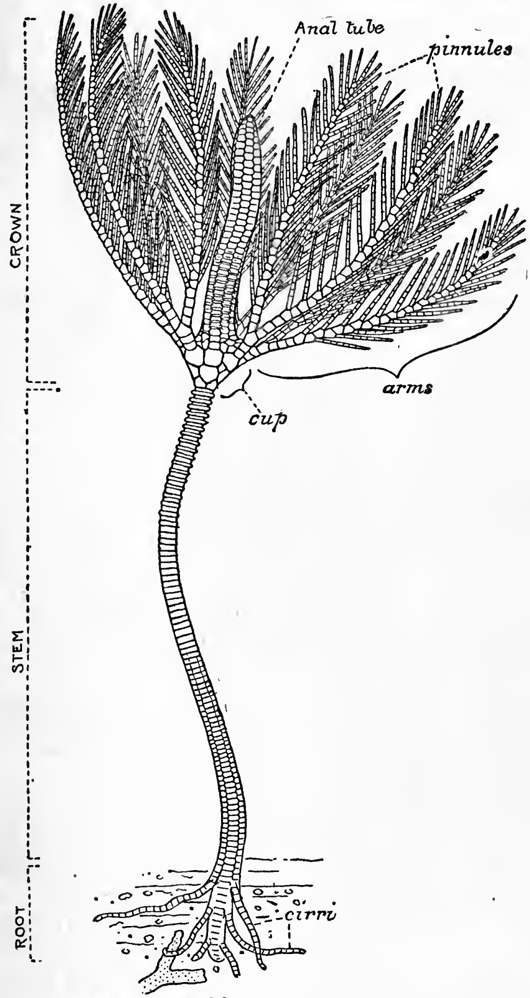



FIG. 155.—Restored figure of *Botryocrinus decadactylus*, Bather (original), a Crinoid from the Wenlock Limestone, on the evidence of specimens in Table-case 73 and Wall-case 18.

**Crinoidea. GALLERY VIII. East Side.**

which are in the Museum (Table-case 73). It is intended to show the main features in the structure of a simple form of crinoid.

**Wall-case 18.** In Palæozoic seas stalked crinoids abounded: some of the slabs of Wenlock Limestone in Wall-case 18 show how many different genera and species lived quite close to one another. The British Silurian crinoids are displayed, with labels explaining their

**Table-case 73.** structure and classification, in Table-case 73. *Mastigocrinus*, *Thenarocrinus*, *Gissocrinus*, *Periechocrinus*, *Glyptocrinus*, and *Taxocrinus* are beautiful and characteristic forms. *Herpetocrinus*, *Calceocrinus*, *Crotalocrinus*, and *Eucalyptocrinus* are remarkable for their curious modifications of structure. The British Carboniferous

**Table-case 74.** crinoids are in Table-case 74. Here a different type, with a large calyx composed of numerous plates, is seen in *Actinocrinus* and *Amphoraerinus*. The crinoids of this period are even more abundant in North America, and some exceptionally fine specimens

**Wall-case 18.** are shown in Wall-case 18. One may note *Gilbertsocrinus* with strange drooping appendages, the spiny *Dorycrinus*, and *Eucladocrinus* with its twisted stem. Some beautiful Devonian crinoids,

**Wall-case 17.** preserved by pyrites in a dark shale, are shown in Wall-case 17. Above them are specimens of the well-known Lily Encrinite (*Encrinus fossilis*) from the Muschelkalk of Brunswick.

Conspicuous among Mesozoic crinoids is *Extracrinus*, of which many magnificent examples from Lyme Regis and elsewhere are

**Wall-case 16.** exhibited in Wall-case 16. Here we note how colonies were formed of many individuals of only one or two species, as is the case to-day. A portion of such a colony from the Lias of Boll, in Würtemberg, forms a beautiful picture in the middle of the case. The stem of this form is said to reach a length of 50 feet; a length of 15 feet is certainly common. The Pear Encrinite (*Apiocrinus*) from the Bradford Clay of Wiltshire is a strangely-

**Table-case 74.** developed type (Table-case 74). In Jurassic and Cretaceous times unstalked crinoids became more common, and remarkable examples are seen in *Marsupites*, from the English Chalk (Table-case 74), and *Uintacrinus*, from rather older rocks in North America (slab on the wall). The common unstalked forms, however, are *Antedon* and *Actinometra*, which, beginning in the Oolites, occur in vast numbers in modern seas, especially in the Eastern Archipelago. Though unstalked and free-moving when grown up, these crinoids are fixed by a stalk when quite young.

Crinoids often flourish in such abundance that their remains

form rock-masses. This fact is illustrated by a small collection at the end of Wall-case 18; also by a fine polished slab from the Mountain Limestone of Derbyshire; this is almost entirely composed of the broken stems of *Actinocrinus*, and is known as crinoid

**Crinoidea. GALLERY VIII. East Side. Wall-case 18.**

Fig. 156.

Fig. 157.

Fig. 156.—Restored figure of *Lepadocrinus quadrifasciatus*, Pearce, sp. (original), a Cystid from the Wenlock Limestone, on the evidence of specimens in the Museum. The armlets of the outer rows are erect; those of the middle row, depressed. Near the top of the left-hand quarter is the anus; near the top of the right-hand quarter is a group of apparent slits, called a "pectinated rhomb."

Fig. 157.—Restored figure of *Orophocrinus fusiformis*, Wachs. and Spr. (original), a Blastoid from the Carboniferous (Kinderhook) of Iowa, U.S.A., on the evidence of specimen E 1726, and of one belonging to F. Springer, Esq. The root is suggested by that of a *Pentremites* in Mr. Springer's collection.

marble. Another slab shows the Silurian Limestone of Gothland, similarly composed of crinoid remains.

## VI.—Cystidea.

**Cystidea.**

**GALLERY VIII. East Side. Wall-case 18, Table-case 75.**

The Cystids (Sack-forms) are the oldest Echinoderms that we know, and approach more nearly to the parent stock from which all the classes have been derived. Owing to their great diversity of form and structure, it is difficult to make any general statements concerning the Cystids as a class. Some have slits in the test, by which, it is probable, the internal fluid was aerated (e.g. *Lepadocrinus*). Some have pores; others have neither slits nor pores. Some have arms free, and either 2, 3, 4, 5, or 6. Others have pinnules fringing ambulacra on the surface of the test (*Lepadocrinus*). Some are spherical (e.g. *Sphæronis*); others are flat and oblong (e.g. *Placocystis*). They were once so numerous as to form rock-masses, as shown in some specimens of *Sphæronis* and *Echinosphæra*, the Crystal-apple of the Scandinavians (Wall-case 18). The British collection (Table-case 75) is very complete.

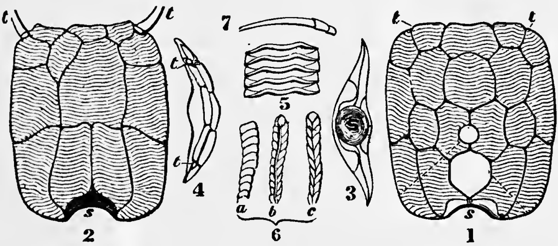



Fig. 158.—*Placocystis Forbesianus*, De Koninck, a flattened Cystid. Wenlock Limestone: Dudley.

*Fig. 1.* Convex side, showing the facets for the spines (*t*, *t*), and the point of attachment for the stem (*s*).
,, *2.* Concave side, showing portions of the spines (*t*, *t*).
,, *3.* View of lower extremity of the body, showing attachment of stem (*s*).
,, *4.* View of the top of the body, showing the facets for the spines (*t*, *t*).
,, *5.* Portion of stem near the body: drawn from a specimen having a portion of the stem still remaining attached.
,, *6.* *a*, *b*, *c*. Three views of a small tapering stem, found detached, but ornamented with wavy ridges like those on the body-plates. Probably the lower extremity of the stem.
,, *7.* One of the spines: drawn from a specimen having the spine still attached to the body. The apparent joints are only cracks.

The originals of these drawings are in Table-case 75.

## VII.—Blastoidea.

**Table-case 75, Wall-case 18.**

The Blastoids (Bud-forms) were a curious little branch from the Cystid stock dominant in Devonian and Carboniferous times.

They had short stems and a large number of fine, short, unbranched arms, arranged on the sides of five broad grooves (see figure 157 on p. 101). Folded pouches, communicating with the outer water, were developed inside the cup, and probably assisted respiration, whence they are called "hydrospires." The British Blastoids (Table-case 75) and the foreign ones (Wall-case 18) contain most of the specimens described by Etheridge and Carpenter in their monograph, published by the Trustees.

**Blastoidea GALLERY VIII. East Side.**

## GALLERY X.

## IV.—CŒLENTERA.

**Cœlentera. GALLERY X. West Side. Wall-cases 1-6, Table-cases 1-10.**

This large group formed the greater part of Cuvier's division "Radiata," which included also the Echinoderma and some less-known groups. It is now, however, known that the radiate symmetry upon which this old division was founded is of less systematic value than the internal anatomy. All those forms, such as the Echinoderms and the Bryozoa, which have the digestive tube definitely separated from the general body-cavity, are removed from their alliance with those in which there is no such definite separation. The latter group forms the phylum of the Cœlentera. This is subdivided into two classes, the Hydrozoa and the Actinozoa, by the same character. The latter includes those which, like the sea-anemones, have a partially developed digestive tube, which is, however, open freely below to the general body-cavity, and thus is "cœlenterate" instead of "cœlomate." The class Hydrozoa is the simpler, and has no such special digestive tube, the inner lining of the body-cavity serving also for the preparation and absorption of the food. The three typical animals belonging to the Cœlentera are the fresh-water Polype or Hydra, the Jelly-fish, and the Sea-Anemone. These are all soft-bodied animals, and it is therefore not surprising that several orders are either unknown or very rarely found in the fossil state. The simplest type of skeleton consists only of spicules: these fuse together into a spicular skeleton, as in the red coral. In others carbonate of lime is deposited in the tissues, and a hard, platy, calcareous skeleton is then formed. The last condition is met with in ordinary corals: as in them

Cœlentera. GALLERY X. West Side. Table-cases 1–9, Wall-cases 1–6.

the skeleton is hard and massive, their remains are abundant in the rocks, and form one of the most important groups known to the geologist.

I. Anthozoa (or Actinozoa).

Subclass 1. Alcyonaria, or Octocoralla: the Sea Pens, Red Coral, etc.
,, 2. Zoantharia, or Hexacoralla.
Order 1. Actiniaria: Sea-Anemones.
2. Antipatharia: Black Corals.
3. Madreporaria: the ordinary Corals.
,, 3. Ctenophora: the Venus Girdle (*Cestum*), the Globe Jelly-fish (*Beroe*), etc.

Among the Anthozoa one subclass (the Ctenophora) and one order (the Actiniaria, or Sea-Anemones) may be at once dismissed, as they are all soft-bodied animals, and no specimens of them are contained in the collection. The fossil Anthozoa, therefore, all belong either to the subclass Alcyonaria, or to the orders Antipatharia and Madreporaria of the subclass Zoantharia.

The Alcyonaria form the subclass including all corals in which the radiating internal partitions (mesenteries and septa) are eight in number, instead of six, and which have fringed tentacles. This subclass is divided into three orders—

1. Alcyonacea, fixed forms with no central rod-like skeleton.
2. Gorgonacea, fixed forms with a central rod-like skeleton.
3. Pennatulacea, free-swimming Alcyonaria, with a flexible, horny stem.

The Zoantharia, on the other hand, include the forms in which the partitions are usually either six in number or some multiple of six.

The actual connection between the soft and the hard parts of many of the Anthozoa is, however, often not very intimate. The skeleton alone is therefore not always sufficient to precisely determine the affinities of the animal which formed it. The classification of the fossil corals is therefore tentative and unsatisfactory, and the collection has been arranged stratigraphically.

The series begins in Table-case 9, and occupies Cases 1–8 and also Wall-cases 1–6. The oldest British fauna represented in the collection comes from the Ordovician rocks of North Wales and Scotland, whence are derived some species of *Favosites* and *Lyopora*. These are generally regarded as Zoantharia, the former being included in the section Perforata, and the latter in that of the

Aporosa. *Favosites* is, however, often claimed by some authorities to be an Alcyonarian. This class finds a better representative in the chain-coral, a species of which (*Halysites catenularia*) began in the same period, and survived until much later.

**Corals. GALLERY X. West Side. Wall-cases 1-5, Table-cases 1-8.**

The Silurian corals in Table-cases 8 and 7 are in better preservation than those of the Ordovician period, but the affinities of many are uncertain. In the first half of Table-case 8 there are forms which are either Anthozoan or Alcyonarian, such as *Favosites*. Some of the remaining specimens in the same half of this table-case may be really Bryozoa—such are *Favositella*, *Coenites*, and *Alveolites*; and others, such as *Syringopora*, are either Alcyonaria allied to the Organ Pipe Coral or are Zoantharia belonging to the order Perforata.

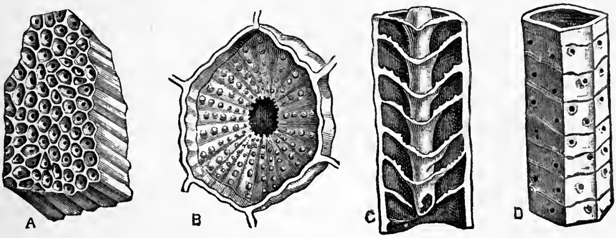



FIG. 159.—A, a fragment of a colony of *Syringolites Huronensis*, Hinde (nat. size); B, a single calice of the same, enlarged eight times, showing the central tube and radiating lines of septal tubercles; C, part of a corallite of same, split open longitudinally and enlarged six times, showing the composition of the central tube out of the invaginated tabulæ; D, part of a corallite of same, viewed from the exterior and enlarged six times, showing the mural pores. Niagara Limestone (Silurian): Manitoulin Island, Ontario, N. America.

On the opposite side of this table-case, are a series of forms belonging to the genus *Monticulipora* and its allies *Monotrypella*, *Fistulipora*, and *Callopora*, which, though left in this gallery for the sake of convenience, ought properly to be transferred to the Bryozoa. Adjoining this series are some fine specimens of a small encrusting coral, *Aulopora*, which grows in an open network over shells and corals; also thick fronds of the aberrant genus *Thecia*, massive growths of *Heliolites* (an ally of the Blue-coral *Heliopora*), and some elegant specimens of the Dudley chain-coral, *Halysites catenularia* (Fig. 160).

The Silurian Corals in Case 7 are of more certain affinities.

**Corals.**
**GALLERY X.**
**West Side.**
**Wall-cases 1-6, Table-case 7.**

They belong to the group of Rugosa, or corals arranged on a quadriradial type, the principal septa being four in number.

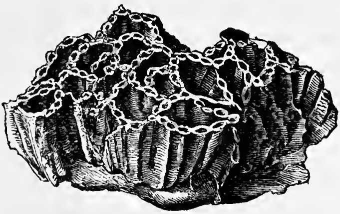


Fig. 160.—The "chain-coral," *Halysites catenularia*, Linn. Wenlock Limestone (Upper Silurian): Dudley.

This group was at one time regarded as distinct from the Hexacoralla and Octocoralla, and has even been included among the Hydrozoa; but it has now been dispersed, some genera, such as *Halysites*, being probably Alcyonaria, and the rest distributed among the Zoantharia. The most interesting Silurian forms

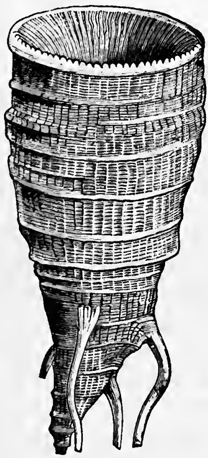


Fig. 161.—*Omphyma subturbinata*, D'Orb. Wenlock Limestone: Dudley. (Prestwich's Geology.)

are the simple pyramidal *Goniophyllum*, discoid *Palæocyclus*, and conical *Omphyma* (Fig. 161); the massive *Strombodes* and *Acervularia*; and *Cyathophyllum*, with its peculiar method of

gemmation, several young growing from the calice of the parent, several cases of which are shown in the collection (*e.g.* R. 2095).

**Corals. GALLERY X. West Side. Wall-cases 1–5, Table-cases 1–8.**

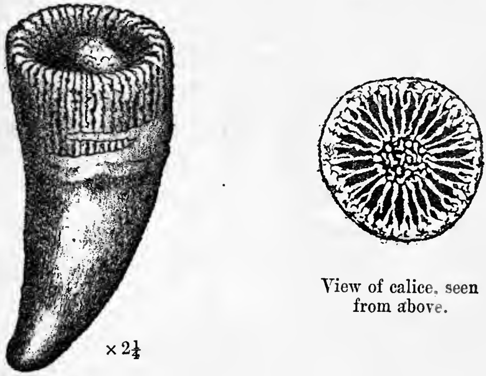



Fig. 162.—*Hemiphyllum Siluriense*, McCoy. Silurian: Wenlock. (Geol. Mag. 1887, p. 99. R. F. Tomes.)

The Devonian Corals occupy the remainder of Wall-case 4 and the whole of No. 5. They belong to much the same types as those of the preceding period, the principal genera being *Alveolites*, *Favosites*, *Syringopora*, *Heliolites*, *Acervularia*, and *Cyathophyllum*.

**Wall-cases 4 & 5.**

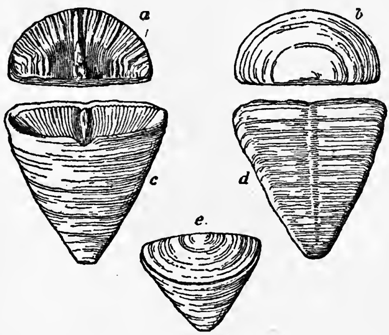



Fig. 163.—*Calceola sandalina*, Lamk., an operculated coral. *a*, the inside, and *b*, the outside, of the operculum; *c*, the front, and *d*, the back, of calice; *e*, specimen with operculum closed over cup. Devonian: Eifel and Devonshire. (Original.)

These corals seem, however, to have grown under more favourable conditions, and in the Middle Devonian rocks of South Devon they

Corals. GALLERY X. West Side. Wall-cases 1–6, Table-cases 1–10.

form regular reefs. The specimens occur in massive limestones, and have to be studied in polished sections, some of which are of great beauty. The examples of *Pachypora cervicornis* in the black limestone of Newton Bushel, *Smithia Pengellyi* in the pink and grey reefs of Barton, and the massive *Cyathophyllum helianthoides* in the red rocks of Torquay and Plymouth, are especially worthy of notice.

The Carboniferous fauna is the last of those of the Palæozoic type; it includes forms such as *Stenopora* and *Monticulipora*, which are probably Bryozoa, and others such as *Chætetes*, referred with some doubt to the Alcyonaria. The four dominant genera are *Syringopora*, *Lithostrotion*, *Lonsdaleia*, and *Zaphrentis*. The general series of corals of this period is shown in Table-cases 4 and 5. In the latter there is a typical series of specimens of *Syringopora* and *Chætetes*. Beside this is the interesting species *Monilopora crassa*, growing in crinoid stems, in which it occasions great deformities. On the other side of this table-case we find the simple cylindrical corals of the genera *Amplexus* and *Campophyllum*; the former is of interest owing to the reduction of the septa, which is compensated for by the great development of horizontal divisions—the "tabulæ." The size which specimens of *Campophyllum* attain is shown by a specimen (R. 2277) from Weston-super-Mare in a case on the wall, while below this is a fine slab of *Dibunophyllum* from Durham. The remainder of Table-case 5 is occupied by specimens of *Lonsdaleia* and *Lithostrotion*, the latter of which extends into the next case. The prismatic columnar corallites of *Lithostrotion basaltiforme* are shown in this series; but reference should be made to Wall-case 4 for some large blocks of *Lithostrotion irregulare* from Fermanagh. In the same case occur some polished slabs of *Cyathophyllum regium* from Bristol.

Table-cases 4 & 5.

The next coral fauna represented in the British islands is that of the Lias, which is the earliest of the Jurassic faunas. This shows that a great change has come over coral-life. The *Syringopora*, *Cyathophyllum*, *Zaphrentis*, and *Lithostrotion*, in fact all the types of the Palæozoic faunas, have disappeared, and are replaced by normal representatives of existing families and genera, such as *Isastræa* and *Montlivaltia* (Fig. 164). The collections from the Inferior Oolite are richer, and the representatives of modern genera are increased by Fungians, such as *Thamnastræa*;

and also by *Latomœandra*, which represents the group of the *Astræidæ confluentes*, so called because the separate calices run together into series as in the Brain Coral.

**Corals. GALLERY X. West Side. Wall-cases 1-6, Table-cases 1-10.**

In the Bath Oolite the corals are of the same types, and the chief reef-builder was *Calamophyllia radiata*. In the

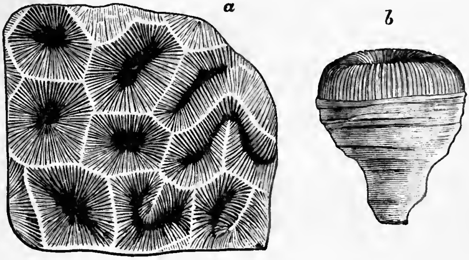



Fig. 164.—*a*, *Latomœandræa Flemingii*, M. Edw. Inf. Oolite: Somerset. *b*, *Montlivaltia trochoides*, M. Edw. Inf. Oolite: Charlcombe. (Prestwich's Geology.)

Coralline Oolite true reefs occur, and are formed of *Thecosmilia*, *Thamnastræa*, and *Isastræa*, of which large specimens are shown in Wall-case 3 (Fig. 165*a*, *b*). Beside these are some masses of

**Oolitic Corals. Wall-case 3.**

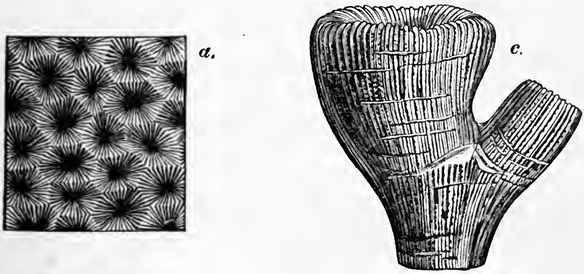



Fig. 165.—*a*, *Thecosmilia annularis*, Flem. Coral Rag: Wilts. *b*, *Isastræa explanata*, Goldf. Coralline Oolite. (Prestwich's Geology.)

*Isastræa oblonga*, from the Portland Oolite of Tisbury, in which the whole of the coral has been converted into chert.

In the Cretaceous the corals were scarcer in England, for the conditions were less favourable to their growth. In the Lower Greensand there is a species, *Holocystis elegans*, famous as it

**Corals.**
**GALLERY X.**
**West Side.**
**Wall-cases 1–6, Table-cases 1–10.**

was once regarded as the only coral of the order Rugosa known later than the Palæozoic. In spite, however, of its four-rayed symmetry, it is now regarded as a normal *Hexacorallum.*

**Cretaceous Corals.**

In the Gault, Upper Greensand, and Chalk, the principal corals are small, simple forms, for the muddy sea-bottom of the first, and the cold of the comparatively deep sea floors of the last, were fatal to reef-builders. The commonest type is conical in shape, such as *Smilotrochus* and *Parasmilia* (Fig. 166*c*); some species of the latter


Fig. 166.—Corals of the Upper Chalk. *a*, *Synhelia Sharpeana*, M. Edw. *b*, *Stephanophyllia Bowerbankii*, M. Edw. *c*, *Parasmilia centralis*, Mant. (Prestwich's Geology.)

are elongate, and become cylindrical, and *Onchotrochus serpentinus* is as narrow and sinuous as a worm tube. Another group of forms are discoid, such as *Cyclocyathus Fittoni* from the Gault, *Trochocyathus Harveyanus* from the Cambridge Greensand, and *Micrabacia coronula* from the Chalk. Some specimens of *Axogaster cretacea* represent the Gorgonias.

In the succeeding period, the Eocene, the Gorgonidæ is represented by two more forms—*Mopsea costata* and *Websteria crisioides.* These

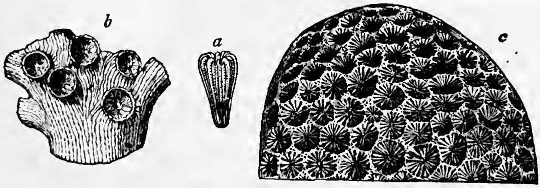



Fig. 167.—*a*, *Turbinolia Dixoni*, Edw. and H. *b*, *Dendrophyllia dendrophylloides*, Lonsd. *c*, *Litharæa Websteri*, Bow. M. Eocene: Bracklesham. (Prestwich's Geology.)

both come from the London Clay, which also yields *Graphularia Wetherelli*, a representative of the Sea-Pens or Pennatulidæ. Except for these, however, the British Cainozoic rocks are barren in interesting fossils belonging to the Cœlentera. In the Bracklesham Beds there occur some branching corals belonging to the genera *Oculina* and *Diplohelia*, and pebbles encrusted by *Litharæa Websteri* (Fig. 167*c*); but with these exceptions the corals are small and simple in the Eocene, and only five small species are known from the English Pliocene.

**Corals. GALLERY X. West Side. Wall-cases 1-6, Table-cases 1-10.**

The foreign Anthozoa occupy Wall-cases 1 to 6. The series begins in No. 6 with a fauna from the Ordovician rocks of America, such as *Protarea*, *Alveolites*, and *Columnaria*, and a group of fossils such as *Constellaria*, *Prasopora*, and *Monticulipora*, which probably belong to the Bryozoa.

**Wall-cases 1-6.**

In the succeeding Silurian period, the most interesting specimens are those collected in the voyage of the "Alert" and "Discovery" in Arctic America. The Devonian collection in Wall-cases 4 and 5 comprises mainly North American species; but it includes some interesting species from Belgium and Germany, notably *Calceola sandalina* (see Fig. 163), which, on account of its lid, or operculum, was once regarded as a Brachiopod. The Carboniferous corals in Wall-cases 3 and 4 include the types of those brought by Sir Roderick Murchison from the Ural Mountains. The Triassic collection is small, but the specimens from the St. Cassian Beds of the Tyrol are of interest.

**Wall-cases 4 & 5.**

**Wall-cases 3 & 4.**

The Jurassic and Cretaceous collections in Wall-cases 2 and 3 illustrate the faunas of Central Europe. The Cainozoic series in Wall-cases 1 and 2 include representatives of the Indian faunas, and many type-specimens of fossil corals from the West Indies.

**Wall-cases 2 & 3.**

**Wall-cases 1 & 2.**

## II. Hydrozoa.

Subclass 1. Acraspedote Hydrozoa.
- Order 1. Tetrameralia } including the typical Jelly-
- 2. Octomeralia } fish and Sea-Blubbers.

Subclass 2. Craspedote Hydrozoa.
- Order 1. Trachymedusæ: a group of Jelly-fish.
- 2. Hydroidea: the fresh-water Polype and Hydroid Zoophytes.
- 3. Siphonophora: the Portuguese Man-of-war and its allies.

The Hydrozoa include all the Cœlentera in which there is no special œsophageal tube below the mouth (though in some

**GALLERY X. Wall-case 6, Table-cases 9 & 10.**

forms a series of canals radiates from the body-cavity), and in which the reproductive organs are contained in external buds. The animals may be simple, as in the fresh-water Polype (*Hydra*), or compound, either growing in plant-like tufts, as the Sea-Fir (*Sertularia*), or massive corals, as in *Millepora*. The colonies are usually fixed, as in the two examples quoted, but in some they are free, as in the order Siphonophora, such as the Portuguese Man-of-War. In many other forms the reproductive individuals ("gonophores") are free-swimming, though the normal forms are fixed.

Of the five orders of the Hydrozoa, four contain only soft-bodied animals, and are not represented in the collection; but in one, the Hydroidea, many genera have horny or calcareous skeletons, which may be preserved in the fossil state. The Hydroidea are divided into the following groups:—

1.—Corynida, in which the polypes are usually tubular, and protected by a calcareous or chitinous covering, but without cup-shaped expansions.

2.—Hydrocorallina, in which the polypes are elongated and tubular, and protected by a massive, calcareous skeleton.

3.—Graptolitoidea, an extinct group in which the skeleton was usually strengthened by a rod.

4.—Thecaphora, forms in which the polypites are protected by cups or hydrothecæ.

1. The Corynida are not a group of much geological importance. The two most interesting forms included within it are *Hydractinia* and *Parkeria*, shown in Table-case 9. The former is represented by some specimens encrusting shells from the Crags, and the latter by some spherical fossils from the Cambridge Greensand, which were formerly regarded as Foraminifera.

2. The Hydrocorallina are mostly included in the same case. In the Chalk there is the genus *Porosphæra*, which has been regarded by some authorities as a sponge. The most important fossils, however, in this group belong to the family Stromatoporidæ, of which a large series is shown in polished slabs of the Devonian Marbles. The genus *Stromatopora* also occurs in the Silurian rocks, where it is associated with *Labechia*, both of which are shown in Table-case 10.

3. The Graptolitoidea form the group of the Hydrozoa of most value to the geologist, for in working out the problems of zonal stratigraphy, the graptolites in the Lower Palæozoic rocks play the same part as do the Ammonites and Brachiopods in the Mesozoic. In Table-case 10 are shown all the leading forms of Graptolites, also a valuable series of type-specimens.

**GALLERY X. Wall-case 6, Table-cases 9 & 10.**

The first important Graptolite fauna in the British series comes from the Skiddaw Slates, one of the lowest members of the Ordovician system, where we find the leaf-like *Phyllograptus*, the bifid *Didymograptus*, the radiating *Loganograptus*, and others, such as *Diplograptus*, with double series of "hydrothecæ" and the cup-shaped expansions protecting the polypes. *Dictyograptus* (*Dictyonema*) *socialis*, from the Tremadoc beds, is older, and shows that graptolites lived in the Cambrian.

In the succeeding Llandeilo and Bala series most of the same genera are present, with simple "monoprionidian" forms, such as *Dicranograptus*, in which there is only a single row of hydrothecæ.

In the Silurian system graptolites with single series became the prevalent forms, notably the genus *Graptolithus* and *Rastrites*, in the latter of which the hydrothecæ are not closely packed along the stem. A good series of these genera from the shales of Dumfriesshire is exhibited, and among them are some slabs of the "*Dawsonia*," which are probably the reproductive polypites, or gonophores, of graptolites.

4. The Thecaphora are perhaps represented by *Dendrograptus*, *Callograptus*, etc.

## V.—PORIFERA.

### SPONGIDA—SPONGES.

**Fossil Sponges. GALLERY X. Table-cases 11–15, Wall-cases 7 & 8.**

Sponges are aquatic organisms of very varied form and size, inhabiting both fresh and salt water. The sponge-animal or sponge-flesh, as shown in the recent, living forms, is a soft gelatinous substance, consisting of microscopic cells, of various forms and functions, which are arranged so as to form an outer membrane, the "ectoderm," of a single layer of flattened cells; an inner membrane, or "endoderm," also of a single layer; and an intermediate layer of varying thickness, usually known as the "mesoderm." The sponge-body is traversed by canals which open at the surface, and are lined by epithelial cells, some of which are

**Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.**

furnished with cilia and a frill-like extension or collar; hence they are termed ciliated or collar-cells. It is by the action of these cells that a constant stream of water is propelled through the sponge, thus furnishing it with food and the means of respiration. The canal system of a sponge consists of incurrent and excurrent canals. The former open at the surface by small apertures or pores, and conduct the water to small chambers lined by the ciliated collar-cells; these are connected with the excurrent canals, which unite together and open by large apertures, or oscules, into a central tubular cavity, or cloaca, or, in many instances, where a cloaca is not present, direct at the exterior surface of the sponge.

The soft, fleshy structures are, in nearly all sponges, supported by a hard skeleton formed in the cellular mesoderm or intermediate layer of the sponge-animal; and this skeleton may be a framework of anastomosing horny fibres, or of siliceous or calcareous spicules of microscopic dimensions, which are either inclosed within horny fibres, or somewhat loosely arranged in the soft tissues, or connected together in various ways to form a firm skeletal meshwork.

In the sponges with horny skeletons of resilient anastomosing fibres, of which the most familiar representative is the ordinary bath-sponge, no mineral particles or spicules have been formed, and these sponges appear to have been incapable of being preserved in the fossil condition, since none have as yet been discovered. All the sponges exhibited in the cases belong either to the Silicispongiæ or to the Calcispongiæ, according as their skeletons are of siliceous or calcareous spicules, and the former of these two groups is by far the most numerous and important.

1.—Silicispongiæ. In this division the spicular elements of the skeleton are composed of amorphous or colloid silica, deposited in delicate concentric layers around a central tube or axial canal, which is usually open at one or both ends of the spicule. In recent sponges the silica of the spicules is as clear and transparent as glass, but it is seldom preserved in this state as fossil; usually the silica is now chalcedonic or entirely crystalline, or it has become of a milky-white tint. In many sponges, such as those from the Upper Chalk of the South of England, the original silica of the skeleton has now nearly entirely been replaced by peroxide of iron or iron-rust, and the sponges appear in section

as rusty bands traversing the chalk or flint. Frequently, also, the siliceous skeleton has been altogether dissolved away, leaving merely an empty cast in the matrix, or very commonly the cast has been refilled with calcite, as in many of the sponges from the Jurassic strata of Würtemberg.

**Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.**

The Silicispongiæ are arranged under the following suborders, according to the form and characters of their skeletal spicules.

I. Monactinellidæ.—The spicules in this group are principally simple, straight, or curved rods or needles, pointed at both ends; they may be also styliform, pin-shaped, or cylindrical, and their surfaces are smooth, spinous, or moniliform. With these are associated smaller flesh-spicules, having the form of hooks, clasps, anchorets, etc. (Fig. 168). The spicules in these sponges are

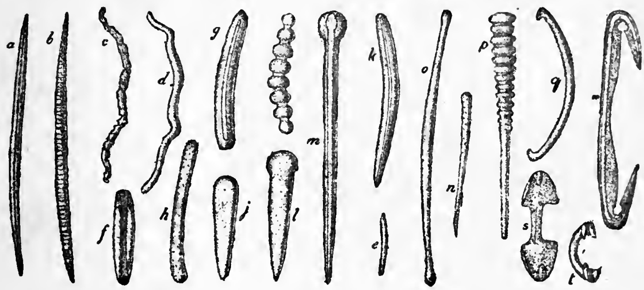



FIG. 168.—Different forms of siliceous spicules of fossil monactinellid sponges. (*a*, *b*, *e*) Fusiform acerate spicules. (*c*) Vermiculate acerate spicule of *Scoliorhaphis*. (*d*) Vermiculate, smooth acerate. (*f*) Acerate spicule with open canal. (*g*) Simple curved cylinder with axial canal completely enclosed. (*h*) Cylinder with microspines. (*i*) Moniliform cylinder. (*j*) Conical spicule. (*k*, *n*) Acuate or styliform. (*l*, *m*) Spinulate or pin-shaped. (*o*) Tibiella spicule. (*p*) Moniliform acuate. (*q*) Bihamate spicule. (*r*) Clasp-hook flesh-spicule. (*s*, *t*) Equianchorate flesh-spicules.

*a*, × 26; *b*, × 100; *c*, × 40; *d*, × 66; *e*, × 26; *f*, × 40; *g*, × 40; *h*, × 114; *i*, × 40; *j*, × 40; *k*, × 40; *l*, × 13; *m*, × 114; *n*, × 114; *o*, × 114; *p*, × 13; *q*, × 40; *r*, × 114; *s*, *t*, × 114.

either inclosed by horny fibres or loosely arranged in the soft tissues. Though the characteristic spicules of this group are met with abundantly in a detached condition in siliceous deposits of Tertiary age for the most part, the sponges themselves are rarely preserved as fossils.

II. Tetractinellidæ.—The characteristic skeletal spicules in this group have four rays extending from a common centre. In the

**Sponges.**
**GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.**

simplest type the rays are equal in length and pointed, and the spicule has the form of a caltrop (Fig. 169*a*, *c*). In other spicules one ray is developed into an elongate shaft, from the summit of which three short simple or furcate rays extend at varying angles, forming a sort of trident. In other spicules the shaft-ray is reduced to a small point, and the three other rays are extended and branched horizontally (Fig. 169*d*). Relatively large fusiform spicules are associated with the four-rayed forms in these sponges. Some sponges also possess a dermal layer or crust of minute kidney-shaped, globate, and flattened, disc-like bodies. The spicules

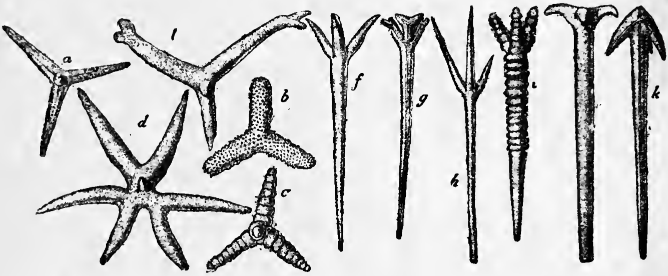



Fig. 169.—Various forms of siliceous spicules of fossil tetractinellid sponges. (*a*) Regular four-rayed or caltrop spicule of *Pachastrella*. (*b*) A micro-spined spicule in which only three rays are developed. (*c*) Moniliform four-rayed or caltrop. (*d*) Trifid spicule in which the shaft is reduced, and the head-rays are furcate and horizontally extended. (*l*) Caltrop spicule of *Pachastrella*. (*f–k*) Trifid spicules showing variously modified head-rays. *a*, × 26; *b*, × 40; *c*, × 54; *d*, × 13; *f*, × 13; *g*, × 26; *h*, × 13; *i*, × 13; *j*, × 26; *k*, × 100; *l*, × 13.

in this group of sponges have generally a radial fascicular arrangement, but they are not fixed together in any way, and consequently they have for the most part been disintegrated in the fossilization, though some entire forms, such as the *Pachastrella convoluta*, Hinde, from the Upper Chalk of Flamborough, have been preserved. On the other hand, detached spicules of these types are extremely abundant, forming the main constituents of beds of sponge-rock in the Lower and Upper Greensand, and also in the Upper Chalk.

III. Lithistidæ.—There is very great variability in the form of the skeletal spicules in different sponges included in this suborder, but they are alike in having the spicules intimately connected with one another by the intertwining and interlocking

of their rays, so as to produce a very strong spicular meshwork capable of enduring fossilization. The suborder has been divided into the following families:—(*a*) Tetracladina; in which the spicules have four equal or subequal rays with their ends produced into twig-like processes, which intertwine with those of adjoining spicules and produce rounded nodes (Fig. 171*c*, *d*). To this family belong such well-known sponges as *Siphonia*, *Hallirhoa*, and *Callopegma*. (*b*) Eutaxicladina. The skeletal spicule in this family has a thickened central node, from which three or more rays are given off. The rays are somewhat expanded at the ends, so as to clasp the nodes of adjoining spicules, and form thereby a close meshwork (Fig. 170*h*). The principal genus in this

**Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11-15.**

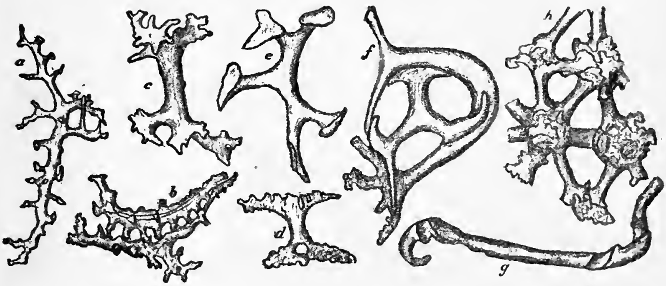



Fig. 170.—Different forms of siliceous spicules of fossil lithistid sponges. (*a*, *b*) Skeletal spicules of a rhizomorine lithistid, *Seliscothon*. (*c*) Skeletal spicule of *Cnemidiastrum*. (*d*) Skeletal spicule of *Aulocopium*. (*e*, *f*) Spicules of a megamorine lithistid, *Doryderma*. (*g*) Spicule of the megamorine lithistid *Carterella*. (*h*) Spicules of the eutaxicladine lithistid, *Astylospongia*.

*a*, × 40; *b*, × 40; *c*, × 40; *d*, × 40; *e*, × 26; *f*, × 20; *g*, × 20; *h*, × 40.

family is *Astylospongia*, Römer. (*c*) Anomocladina. The skeletal spicule consists of a rod-like axis, provided with an axial canal and with a thickened node at each end, from which a variable number of rays are given off. The termination of the rays and their mode of union are the same as in the preceding family (Fig. 171*b*). *Cylindrophyma* and *Melonella* are the principal genera. (*d*) Megamorina. The spicules in this family are relatively large, curved, and irregularly branching rods, with a simple axial canal. These are in some cases intertwined together like wicker-basket work; in other cases the ends are expanded so as to clasp adjoining spicules (Fig. 170*e*, *f*). The surface layer in some of the sponges consists of regular trifid spicules.

Sponges.
GALLERY X.
West Side.
Wall-cases 7 & 8,
Table-cases 11-15.

The typical genus in this family is *Doryderma*, Zittel, which is abundant in the Upper Greensand and Upper Chalk. (*e*) Rhizomorina. The skeletal spicule is relatively small, usually elongate, curved and irregularly branching, with minute projecting spines. The branches terminate in minute facets, which are closely apposed to the axis and branches of adjoining spicules so as to form an irregular meshwork or loosely-arranged fibres (Fig. 170*a*, *b*). Typical genera are *Verruculina*, Zitt., and *Chenendopora*, Lamx.

Owing to the firm manner in which their skeletons are built up, Lithistid sponges are abundant as fossils, and they are more numerously represented in the Museum collection than the Hexactinellids. They exhibit the greatest diversity in form and

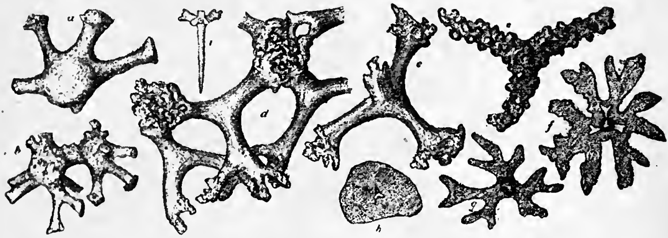



Fig. 171.—Different forms of skeletal and dermal spicules of fossil lithistid sponges. (*a*) Skeletal spicule of eutaxicladine lithistid, *Mastosia*. (*b*) Skeletal spicule of anomocladine lithistid, *Cylindrophyma*. (*c*, *d*) Skeletal spicules of tetracladine lithistid, *Callopegma*. (*e*) Skeletal spicule of tetracladine lithistid *Plinthosella*. (*f*, *g*, *h*, *i*) Dermal spicules of lithistid sponges.

*a*, × 40; *b*, × 40; *c*, × 40; *d*, × 40; *e*, × 26; *f*, × 40; *g*, × 40; *h*, × 40; *i*, × 40.

size, from small rounded specimens not more than 6 mm. or ¼ inch in diameter, to cylindrical or club-shaped examples 320 mm. or 13 inches in height and 105 mm. or 4¼ inches in thickness. Cup-, pear-, and platter-shaped forms are also very common. Numbers of these sponges have, however, been broken up into their constituent elements in fossilization, for their detached spicules are extremely abundant in some of the beds of sponge-remains in the Upper Greensand, and also in the interior of flints from the Upper Chalk.

IV. Hexactinellidæ.—In this suborder the characteristic spicule has six rays, or arms, meeting in a common centre at right angles. There is an axial canal in each ray, which connects at the centre of the spicule with the canals from the other rays (Fig. 172*a*).

**Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.**

The central node of the spicule may be simple or slightly inflated, but in many sponges of this group it has the form of a hollow octahedron, and such spicules have been termed lantern-spicules. This form is present in the genus *Ventriculites*. Smaller flesh-spicules of very varied and beautiful forms are present in recent Hexactinellids, but it is very rarely that they are found fossil (Fig. 172*g*, *h*).

In one division of these sponges, known as the Lyssakina, the spicules are either loosely imbedded in the soft tissues or arranged in the form of a definite meshwork, but they are not as a rule cemented together; in the division of the Dictyonina, however,

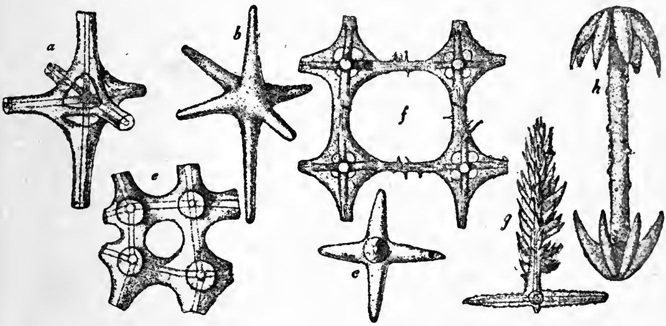



Fig. 172.—Spicules and fragments of the spicular mesh of fossil hexactinellid sponges. (*a*) Spicule with lantern or octahedral node, showing the axial canals extending from the centre of the node. (*b*) Detached spicule with compact node. (*c*) Spicule in which only five rays are developed. (*e*) Fragment of spicular mesh of dictyonine hexactinellid, *Sestrodictyon*. (*f*) Fragment of spicular mesh with lantern nodes of *Cœloptychium*. (*g*) Pinule flesh-spicule. (*h*) Amphidisc flesh-spicule.

*a*, × 66; *b*, × 40; *c*, × 40; *e*, × 47; *f*, × 40; *g*, × 134; *h*, × 114.

the spicular arms of adjoining spicules overlap each other, and are completely fused together in a deposit of silica so as to form a connected skeletal framework with definite quadrate or cubical interspaces (Fig. 172*e*, *f*). These sponges, moreover, are frequently invested with a perforated exterior siliceous membrane, formed by modified spicules. Another peculiar feature of Lyssakine Hexactinellid sponges is the development of twists or tufts of very elongate, rod-like spicules, which served to anchor the sponge in the soft mud of the sea-bottom. Frequently these anchoring spicular tufts are preserved in the rocks, whilst the body-skeleton of the sponges has completely disappeared.

Sponges.
GALLERY X.
West Side.
Wall-cases 7 & 8,
Table-cases 11-15.

The Lyssakine division includes a number of forms mostly from Palæozoic rocks, which are but very imperfectly known owing to their fragmentary condition. They have been placed in the families of the Protospongidæ, Dictyospongidæ, and Plectospongidæ.

The Dictyonine Hexactinellids comprise a very large number of fossil forms, whose preservation is due to the manner in which the spicular mesh has been fused into a connected framework. They have been divided into the following families:—(*a*) Craticularidæ. Mostly cup- or funnel-shaped; spicular nodes simple and not perforate. Canal apertures large, simple, ending blindly in the skeleton. (*b*) Coscinoporidæ. In addition to cup- and funnel-shaped forms, many sponges of this family have thin walls, folded into a series of flanges, as in the Cretaceous genus *Guettardia*. The surface canal apertures are small, and usually regularly arranged in quincunx. (*c*) Staurodermidæ. Usually funnel-shaped or cylindrical sponges, with an irregular skeletal mesh, and a very definite dermal layer in which large cruciform spicules are imbedded. (*d*) Ventriculitidæ. Mostly funnel-shaped sponges in which a thin wall is folded vertically and usually radially arranged. The spicular nodes are hollow or lantern-shaped, and there is a modified dermal layer. The base of the sponge has root-like extensions of spicular fibres. *Ventriculites*, Mant., is numerously represented in the Upper Chalk. (*e*) Cœloptychidæ. The sponges are mushroom-shaped, and they consist of a thin wall arranged in radial folds and inclosed in a perforate siliceous dermal layer. Canal apertures are in rows on the ridges of the under-surface. The spicular mesh with lantern nodes. (*f*) Mæandrospongidæ. These sponges are pear- or sack-shaped, or in irregular nodose masses, which consist of numerous anastomosing folds of a thin wall of delicate spicular meshwork. These folds are in some forms either partially or entirely inclosed in a case of fine spicular membrane, as in the genera *Camerospongia*, D'Orb., and *Cystispongia*, Römer. To this family belongs also *Plocoscyphia*, Reuss, which is common in the Upper Chalk.

Hexactinellid sponges contrast generally with the preceding group of Lithistids in having thin, delicate walls surrounding wide, funnel-shaped, or cylindrical, cloacal cavities. In those instances in which an apparently thick wall forms the body of the sponge, it is usually found to really consist of numerous convolutions of a simple thin wall of spicular tissue.

V. Octactinellidæ.—The normal spicule of this suborder has eight rays, six of which are in a horizontal plane radiating from a common centre, whilst the other two rays form a vertical axis. One or both the vertical rays are often reduced or absent. The only representatives of this division are the discoidal forms of *Astræospongia*, Römer, from the Silurian. **Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.**

VI. Heteractinellidæ.—The skeletal spicules are of relatively large size, and consist of an indefinite number of rays or arms, varying from six to thirty, radiating from a common centre (Fig. 173*a*). The body spicules are irregularly arranged in the soft tissues; those of the dermal layer are interwoven together, and their rays are in part fused with each other. Only fragments of these sponges are as yet known. It may be mentioned that Zittel considers that this and the preceding group are but aberrant Hexactinellid sponges.

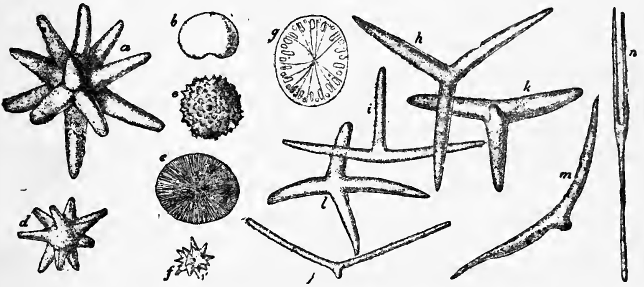



FIG. 173.—Different forms of siliceous heteractinellid and multiaxial spicules and also spicules of fossil calcisponges. (*a*) Spicule of *Asteractinella*, with twelve rays. (*b*, *c*) Dermal spicules of *Geodia*. (*d*) Globostellate spicule. (*e*) Microspined globate spicule. (*f*) Stellate flesh-spicule of tetractinellid sponge. (*g*) Flattened disc-shaped, probably dermal, spicule. (*h*) Three-rayed equiradiate spicule of calcisponge. (*i*) Three-rayed sagittate spicule of calcisponge. (*j*, *m*) Three-rayed spicules of calcisponge, *Tremacystia*. (*k*, *l*) Four-rayed spicules of calcisponge, *Tremacystia*. (*n*) Three-rayed (tuning-fork) spicule of calcisponge.

*a*, × 13; *b*, × 66; *c*, × 66; *d*, × 66; *e*, × 66; *f*, × 167; *g*, × 66; *h*, × 26; *i*, × 114; *j*, × 134; *k*, × 80; *l*, × 80; *m*, × 134; *n*, × 134.

RECEPTACULITIDÆ.—This group of organisms, which includes the genera *Receptaculites*, *Ischadites*, and *Sphærospongia*, has been described by Hinde as a family of Hexactinellid sponges, but it has been shown by Rauff that the spicular bodies of which they are composed are probably of carbonate of lime. Their systematic

Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.

position is at present altogether problematical, but they are placed in the same cases as the sponges until their true relations are known.

2. — CALCISPONGIÆ. In this division the skeleton consists principally of three- and four-rayed spicules, and also of simple, needle-like, uniaxial spicules, which are formed of carbonate of lime (Fig. 173*h–n*). There is the same manifold variety of form in the Calcisponges as in Silicisponges, and their canal system is of a similar character.

The spicules in most of the recent forms are either loosely distributed in the soft tissues, or have a definite radial arrangement to form canals as in the Sycones, but in nearly all the known fossil forms they are arranged in definite anastomosing fibres.

The structure of Calcisponges in many instances has been very greatly altered in fossilization. The spicules in the fibres have lost their outlines, and the fibres now appear as if entirely formed of granular or fibrous calcite. In other cases the fibres have been replaced by silica, so that they remain after treatment with acid, but all traces of spicules have been obliterated. In some specimens of *Pharetrospongia*, preserved in solid flint, the outer portion of the fibres has been replaced by silica, whilst their interiors yet retain the original structure of carbonate of lime. The structure even in the best-preserved specimens of Calcisponges is hardly at all recognizable, unless in thin sections under the microscope.

Fossil Calcisponges have been arranged in the following families:—

(*a*) Pharetrones.—In this division, which comprises the large majority of the fossil forms, the skeletal spicules are arranged side by side in close contact with each other so as to form cylindrical fibres, which anastomose together. The spicules are not organically attached or fused together in any way, and it is surprising that fibres formed in this way should have been preserved intact. In some forms there is a relatively large three- or four-rayed spicule in the axial portion of the fibre, which is enveloped by smaller filiform spicules, whilst in others the spicules are equal or sub-equal throughout. In many of the sponges there is a smooth or wrinkled dermal layer formed of a close felt-work of spicules. The Pharetrones have been divided into numerous genera. The most important are *Peronidella*, Zitt., *Corynella*, Zitt., *Elasmostoma*, Fromentel, *Pharetrospongia*, Sollas, and *Holcospongia*, Hinde.

(*b*) Leucones.—The spicules in this family are loosely and irregularly distributed in the soft tissues. Sponges of this family are very abundant in recent seas, but extremely rare as fossil, and the only ones yet discovered in the rocks are some diminutive specimens of *Leucandra Walfordi*, from the Middle Lias, which are not more than 2 to 4 mm., or about $\frac{1}{8}$ inch, in height, and about 1 mm. or $\frac{1}{25}$ inch in thickness. **Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.**

(*c*) Sycones.—In this division the spicules are so arranged as to form radial tubes which open into the cloacal cavity. Fossil forms are rare, and those assigned here are not definitely similar to the living sponges of the group. They include *Prōtosycon*, Zitt., and *Barroisia*, Mun. Chal.

## GEOLOGICAL DISTRIBUTION OF FOSSIL SPONGES.

As the fossil sponges in the Museum have been arranged in stratigraphical order, their distribution in the different horizons of the geological series can be readily seen by an examination of the contents of the cases in regular sequence. **Table-case 15.**

Palæozoic.—Beginning at the base of the series, we find the oldest known sponge, *Protospongia fenestrata*, Salt., from the Cambrian rocks of St. Davids, South Wales. It belongs to the Lyssakine Hexactinellids; the only portions known are small fragments of the siliceous meshwork now replaced by pyrites and inclosed in black shale.

From the Ordovician there are the anchoring tufts of Hexactinellid sponges and the remarkable Hexactinellid *Brachiospongia digitata* from Kentucky. **Wall-case 8.**

The Silurian sponges of this country are represented by the Hexactinellid genus *Plectoderma*, and the aberrant and somewhat doubtful *Amphispongia oblonga*. From the same horizon in North America, are found the Monactinellid *Climacospongia*, and the numerous examples of the Lithistid genera *Astylospongia*, *Palæomanon*, and *Hindia*. The Octactinellid genus *Astræospongia* comes from Tennessee and the Isle of Gothland, and from this latter place the Lithistid *Aulocopium*.

From the Silurian and Devonian strata of Belgium, North America, and this country, are many examples of *Receptaculites*, *Ischadites*, and *Sphærospongia*. Casts of the Hexactinellid genus *Dictyophyton* are from the Devonian of North America. **Table-case 15.**

Sponges.
GALLERY X.
West Side.
Wall-cases 7 & 8,
Table-cases 11-15.

From the Carboniferous Limestone of Yorkshire there are well-preserved examples of the anchoring spicular ropes of *Hyalostelia* and small portions of the peculiar *Tholiasterella* and *Asteractinella.* Detached spicules of *Pachastrella, Geodites,* and *Doryderma,* prove the occurrence of these Tetractinellid and Lithistid genera in the Carboniferous period.

Wall-case 8.
Table-case 14.

Mesozoic.—From the Triassic strata of St. Cassian there is a series of small Calcisponges which have been referred to *Stellispongia, Corynella,* and other genera of Pharetrones.

From the Great Oolite and the Corallian beds of this country many fairly well-preserved Calcisponges have been obtained belonging to *Peronidella* (Fig. 174), *Corynella, Eusiphonella, Lymnorella,* and *Holcospongia.*

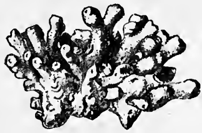


Fig. 174.—*Peronidella pistilliformis,* Lamx. Great Oolite: Hampton Cliff, near Bath. (Reduced one-half.)

Wall-case 8.

The Upper or White Jurassic strata of Würtemberg and Switzerland contain a large number of Lithistid and Hexactinellid sponges, some beds of the rock being mainly composed of these organisms. They retain their outer form, but in nearly all, the siliceous skeleton has been replaced by calcite. A representative series is shown, comprising the Lithistid genera, *Cnemidiastrum, Hyalotragos, Pyrgochonia, Leiodorella, Platychonia, Placonella, Cylindrophyma,* and *Melonella,* and the following Hexactinellids: *Tremadictyon, Craticularia, Sphenaulax, Sporadopyle, Verrucocœlia, Pachyteichisma, Trochobolus, Cypellia, Stauroderma, Casearia,* and *Porospongia.* Some of these genera also occur in the Inferior Oolite of Dorsetshire.

Table-case 14.

Passing now to the Cretaceous system, the Lower Greensand of Faringdon, in Berkshire, yields a great variety of Calcisponges, retaining their forms very perfectly. They belong to *Rhaphidonema, Barroisia* (*Tremacystia*), *Peronidella, Corynella, Elasmocœlia, Oculospongia,* etc. The chert beds of the Lower Greensand in Kent and Surrey are mainly composed of detached siliceous spicules of

Tetractinellid and Lithistid sponges; but the sponges themselves are very seldom preserved. **Sponges. GALLERY X. West Side.**

The Gault is very poor in sponges; but the Upper Greensand, the Chalk Marl, and the Chloritic Marl of Eastbourne, near Folkestone, Blackdown (Devon), and more particularly in the vicinity of Warminster, Wiltshire, contain great numbers, which still preserve their original form and structures. A large series is exhibited. The principal Hexactinellid genera are *Plocoscyphia*, *Craticularia*, *Stauronema*, and *Leptophragma*. Lithistid sponges are very numerous, more particularly those belonging to the Megamorina and Tetracladina family; they comprise *Doryderma*, *Pachypoterion*, *Nematinion*, *Carterella*, *Siphonia*, *Hallirhoa*, *Jerea*, *Kalpinella*, *Rhopalospongia*, and *Chenendopora*. The Calcispongiæ are less prominent in these beds; they include *Peronidella*, *Corynella*, *Tremacystia*, *Elasmostoma*, *Pharetrospongia*, and *Pachytilodia*. More particularly worthy of mention are the peculiar lobate forms of the Lithistid *Hallirhoa* (Fig. 175) with long stems; the **Wall-cases 7 & 8. Table-cases 13 & 14, Wall-case 8.**

FIG. 175.—*Hallirhoa costata*, Lamx. Upper Greensand: Warminster. (Reduced to one-fourth.)

very perfect *Siphoniæ* from Blackdown; the large goblet forms of *Pachypoterion*; and the cylindrical and branching examples of *Doryderma* (Fig. 177) from near Warminster.

In the Chalk itself, comprising both the Upper and Lower or Grey Chalk, the sponge fauna is perhaps more highly developed than in the Upper Greensand, but the sponges themselves are less favourably preserved. Those from the Upper Chalk of the South

Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.

of England have had their skeletons nearly entirely replaced by iron-peroxide; very frequently also they are now enclosed in nodules of solid flint, in part retaining their forms, but their interior structures are now merged in the flinty matrix, and only

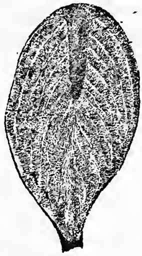



Fig. 176.—Vertical median section of a lithistid sponge, *Siphonia tulipa*, Zittel, showing the cloaca (*cl.*), the fine incurrent canals (*in.*), and the excurrent canals (*ex.*) opening into the cloaca. Upper Greensand: Warminster, Wilts. (Reduced one-half.)

Fig. 177.—*Doryderma dichotomum*, Benett, a megamorine lithistid sponge. Upper Greensand: Warminster, Wilts. (Reduced to one-fourth.)

show the course of the larger excurrent canals and the cloacal cavity. In the sponges from the Upper Chalk of Flamborough, Yorkshire, the form is usually preserved, and also the main

features of the canal system, but the spicular structure is now scarcely recognizable. (Fig. 178.)

**Sponges. GALLERY X. West Side. Wall-cases 7 & 8, Table-cases 11–15.**

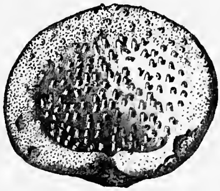
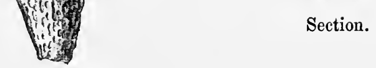


FIG. 178.—*Verruculina Reussii*, M'Coy. Upper Chalk: Flamborough Head. (Reduced to one-third.)

The principal Lithistid genera in the Upper Chalk are *Seliscothon*, *Verruculina* (Fig. 178), *Stichophyma*, *Jereica*, *Scytalia*, *Pachinion*, *Doryderma*, *Heterostinia*, *Isorhaphinia*, *Phymatella*, *Callopegma*, *Siphonia*, *Thamnospongia*, *Plinthosella*, and *Phymaplectia*. The Hexactinellid genera comprise *Craticularia*, *Leptophragma*, *Coscinopora*, *Guettardia*, *Ventriculites* (Fig. 179), *Polyblastidium*, *Cephalites*,

**Table-cases 11 & 12, Wall-case 7.**



Section.

FIG. 179.—*Ventriculites infundibuliformis*, S. Woodw., a Hexactinellid sponge, reduced from Cat. Foss. Sponges, pl. xxvi. Upper Chalk.

*Plocoscyphia*, *Camerospongia*, *Callodictyon*, and *Cœloptychium*. Tetractinellid sponges are represented by *Pachastrella* and *Stelletta*, and by numerous detached trifid spicules of *Geodia* (?). Monactinellid sponges include boring forms of *Cliona*. The Calcisponges are not very numerous; they belong principally to *Elasmostoma* and *Pharetrospongia*.

Among the more striking examples of the Upper Chalk sponges

GALLERY X. may be mentioned the different species of *Ventriculites*, some of which show the folding or plaiting of their walls very distinctly (Fig. 179). Also the wide flange-like walls of *Guettardia*, and the peculiar mushroom-shaped specimens of *Cœloptychium*. In the specimens of this latter from the Upper Chalk of Westphalia, the form and structure are perfectly preserved. The large size and the projecting canal apertures in the Lithistid *Stichophyma* and *Verruculina* from the Flamborough Chalk are also worthy of notice.

The only representatives of fossil sponges from Tertiary rocks are the borings of species of *Cliona* in molluscan shells.

## VI.—PROTOZOA.

### RHIZOPODA.

GALLERY X. Table-case 16. Wall-case 9.

1.—Radiolaria. In this order of the Rhizopoda, the sarcode-body is differentiated into a central mass of protoplasm of a more viscous character, which is inclosed in a porous membrane or capsule. The intracapsular sarcode contains vacuoles, nuclei, granules, and fat globules. The exterior layer of sarcode which surrounds the capsule is jelly-like, and from this pseudopodia, in the form of slender radiating filaments, are given off. The majority of Radiolaria secrete a skeleton either of an organic chitin-like substance known as "acanthin," or of a "silicate of carbon," or of clear glassy silica. Only the skeletons formed of this last-mentioned material are known as fossil.

There is an extraordinary variety of form in the skeleton of Radiolaria. The simplest type is a spherical shell of open lattice-work (Fig. 180, *4*), or there may be two or more concentric latticed shells, connected by radial bars which project beyond the shell as long spines (Fig. 180, *1*). Latticed ellipsoidal and discoidal forms are also common. In another group, the typical shape is an elongated latticed cone or bell, which has frequently a spine at the apex, and others projecting from the basal margins. The cone may be undivided or partially marked off by transverse constrictions (Fig. 180, *3*). In all cases the Radiolaria are of microscopic dimensions, and scarcely, if at all, visible to the unaided sight.

Radiolaria are all marine; many of them live near the surface in tropical seas, and their skeletons sink to the bottom of the ocean, where they are now forming extensive deposits of radiolarian ooze at depths of from 2000 to 4000 fathoms.

**GALLERY X. Wall-case 9, Table-case 16.**

Until very lately fossil remains of Radiolaria were only known from soft siliceous marls and shales of Tertiary age which occur in Barbados, Cuba, Trinidad, Richmond in Virginia, Sicily, and the Nicobar Islands. The Radiolaria in these deposits retain the glassy silica of their shells, and for the most part they are in as perfect condition as recent forms, and many are of the same species as those now living. From these soft deposits, usually of a white

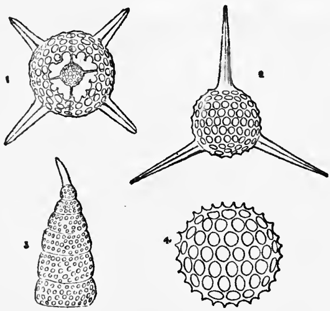



Fig. 180.—Fossil Radiolaria. (1) *Stauroloncha macracantha*, Rüst; from the Carboniferous of Sicily. (2) *Theodiscus convexus*, Rüst; from the Carboniferous of the Harz. (3) *Lithostrobus Wendlandi*, Rüst; Carboniferous, Sicily. (4) *Cenosphæra macropora*, Rüst; Silurian, Cabrières.—All largely magnified. (After Rüst.)

chalky-looking rock, the tests may be obtained by washing. A large block of this radiolarian rock from Barbados is shown in Wall-case 9, and some of the Radiolaria from it are on a glass slide.

It has recently been ascertained, moreover, that Radiolaria may be of great geological age, and that they occur in siliceous rocks of all formations from the Cambrian upwards. They have been found in Cambrian strata in Thuringia; in dark or reddish cherts of Ordovician age in the South of Scotland, specimens and sections of which are exhibited in Table-case 16; also, of probably the same age, in Cornwall; in siliceous shales at

GALLERY X. Wall-case 9, Table-case 16.

Cabrières, in Languedoc, and in Saxony. In jaspers of Devonian age in Siberia, and in the Kieselschiefer of Hesse and Nassau, they are abundant. Widely-distributed beds of chert and siliceous shale, filled with their remains, have been found in the Lower Culm or Carboniferous strata of Devonshire and Cornwall, and in jasper and whetstones of the same age, in the Harz, the Ural Mountains, and in Sicily. Radiolarian rocks of Triassic age have been met with in Hungary; of Liassic age in Hanover and the Tyrol; and of Jurassic age in Italy and Hungary. Beds of considerable thickness of radiolarian chert, and probably of Cretaceous age, form part of the coast ranges of Southern California, and these same organisms occur in Cretaceous beds in Westphalia, Manitoba, and occasionally in the Upper Chalk of this country.

The Radiolaria in the Mesozoic and Palæozoic rocks usually occur in hard massive beds of chert, hornstone, jasper, or in hard siliceous shales or kieselschiefer, which appear to have been mainly formed of their siliceous skeletons. In these rocks the organisms can only be studied by making thin microscopic sections. In most cases the Radiolaria in these rocks have had their latticed walls dissolved away, and only the casts of their shells, which appear as circular, oval spots of transparent silica, have been preserved. Exceptionally, pieces of the rock are met with in which the structures are retained, and they are found to possess equally as delicate and beautiful tests as the living forms of the group.

Radiolaria have been divided by Haeckel into the four suborders of Acantharia, Spumellaria, Nassellaria, and Phœodaria, but only the second and third of these are found fossil. In the Spumellaria the tests are principally spherical, ellipsoidal, or discoidal in shape (Fig. 180, *1*, *2*, *4*), whilst in the Nassellaria they are usually conical or bell-shaped (Fig. 180, *3*).

GALLERY X. Table-case 16, Wall-case 9.

2. — Foraminifera. These also belong to the most lowly organisms of the animal kingdom. Their soft structures consist of sarcode, an albuminous substance of a jelly-like consistency and contractile character, which has the power of sending out thread- or finger-like processes called pseudopodia, which coalesce with each other, and can readily be emitted from, and again withdrawn into, the body-substance. The

pseudopodia serve for obtaining food and for locomotion. There are no definite tissues, nor any separate body-cavity, and all the processes of life, such as digestion, excretion, respiration, etc., are carried on by the undifferentiated sarcode or protoplasm. Further, the sarcode, in the case of the Foraminifera, forms solid, hard shells, or tests, which in a few cases are of a chitinous or horny character, but more usually are of carbonate of lime, or of minute particles of sand or other foreign materials, neatly cemented together.

**GALLERY X.**

**Wall-case 9, Table-case 16.**

The shell, or test, in its simplest form, may consist of a single spherical or oval chamber of microscopic dimensions, with a definite aperture and walls which may either be perforated with minute tubules or non-perforate. The animal sarcode fills the chamber and sends out its pseudopodial extensions through the opening, and also, in the perforate forms, through the minute tubules of the wall, in the form of long, delicate threads. In the less simple forms the test is divided by septa into a variable number of chambers, or there is a succession of chambers attached together and communicating by their apertures with each other. It is from the shape of the individual chambers, and the mode in which they are attached together, either in straight lines, spirals, concentric rings, alternating straight or spiral rows, or irregular aggregations, that the marvellous variety of form of the foraminiferal test results.

The greater number of Foraminifera possess tests of carbonate of lime, and these may be either porcellaneous and imperforate, or glassy (hyaline, vitreous) and perforate. In the porcellaneous group the test is compact, opaque-white, and without minute pores or tubules, so that the pseudopodia can only pass through the oral aperture. In the glassy-porous group the shell is translucent and shiny, and it is penetrated by numerous minute canals. In certain of these porous shells there is also a system of coarse anastomosing canals in the septa, or in the median plane of the spiral folds, which do not connect with the pores; and in many of the more complex forms there is an intermediate skeletal layer. The "arenaceous" tests are built up of sand-grains, minute shells, sponge-spicules, and other extraneous particles cemented by lime or siliceous materials. These shells may be either compact or with perforate walls. In some instances the wall of the test consists of an inner calcareous

**GALLERY X. Wall-case 9, Table-case 16.**

layer and an outer arenaceous layer of cemented sand-grains (Fig. 181).

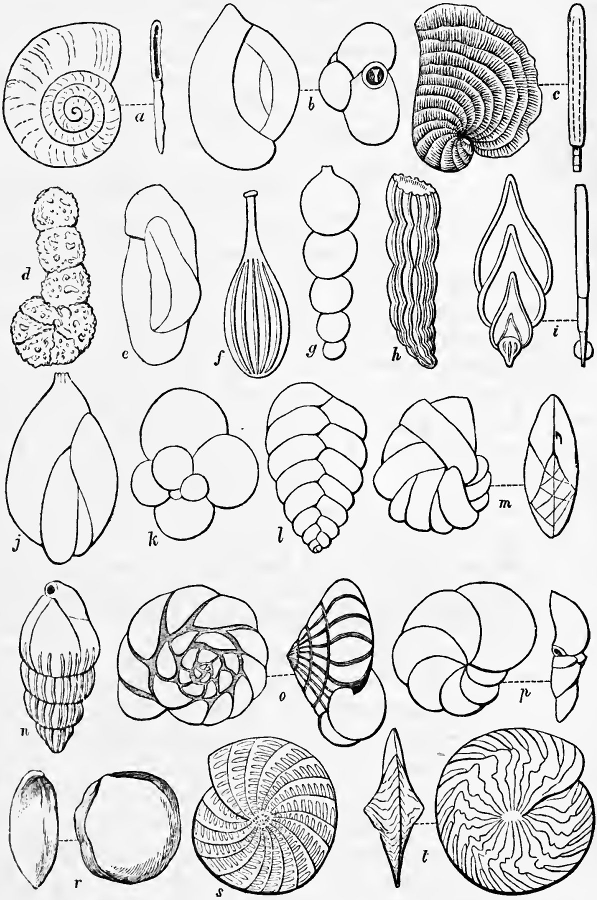



FIG. 181.—Types of Foraminifera. *a*, *Cornuspira foliacea*; *b*, *Quinqueloculina seminulum*; *c*, *Peneroplis pertusus*; *d*, *Lituola agglutinans*; *e*, *Trochammina pusilla*; *f*, *Lagena sulcata*; *g*, *Nodosaria radicula*; *h*, *Marginulina raphanus*; *i*, *Frondicularia Archiaciana*; *j*, *Polymorphina lactea*; *k*, *Globigerina bulloides*; *l*, *Textularia sagittula*; *m*, *Cassidulina lævigata*; *n*, *Bulimina Buchiana*; *o*, *Rotalia Beccarii*; *p*, *Truncatulina lobatula*; *r*, *Archædiscus Karreri*; *s*, *Polystomella crispa*; *t*, *Amphistegina Lessoni*.—All the figures are greatly enlarged, the real diameters varying from $\frac{1}{100}$ to $\frac{1}{10}$ inch (H. B. Brady). (Nicholson's Palæontology.)

Various modes of classification have been proposed for the Foraminifera: the following was brought forward by the late Conrad Schwager, and has been adopted by Zittel:— **GALLERY X. Wall case 9, Table-case 16.**

Suborder I. CHITINOSA. Family Gromidæ. The test is chitinous and not known as fossil.

Suborder II. AGGLUTINANTIA. Test composed of sand-grains or other siliceous bodies agglutinated together by a compact siliceous or calcareous cement. Fam. 1. Astrorhizidæ; typical genus, *Saccammina*, Sars. Fam. 2. Lituolidæ; typ. gen., *Lituola*, Lam., *Placopsilina*, D'Orb. Fam. 3. Orbitolinidæ; typ. gen., *Orbitolina*, Lam.

Suborder III. PORCELLANEA. Test of carbonate of lime, porcellaneous. Fam. 1. Nubecularidæ; typ. gen., *Nubecularia*, Defr. Fam. 2. Peneroplidæ; typ. gen., *Peneroplis*, Montf., *Orbitolites*, Lam., *Alveolina*, Bosc. Fam. 3. Miliolidæ; typ. gen., *Miliola*, Sch.

Suborder IV. VITRO-CALCAREA. Test of glassy-porous carbonate of lime, rarely arenaceous, or arenaceous with a glassy-porous substratum, perforated by fine canals for the emission of the pseudopodia. Fam. 1. Lagenidæ; typ. gen., *Lagena*, Walk., *Nodosaria*, Lam., *Dentalina*, D'Orb., *Frondicularia*, Defr. Fam. 2. Textularidæ; typ. gen., *Textularia*, Defr., *Climacammina*, Brady. Fam. 3. Globigerinidæ; typ. gen., *Globigerina*, D'Orb. Fam. 4. Rotalidæ; typ. gen., *Rotalia*, Lam., *Discorbina*, Park., *Endothyra*, Phill., *Calcarina*, D'Orb. Fam. 5. Fusulinidæ; typ. gen., *Fusulina*, Fisch. Fam. 6. Nummulinidæ; typ. gen., *Nummulites*, D'Orb., *Amphistegina*, D'Orb., *Polystomella*, D'Orb., and *Orbitoides*, D'Orb.

With the Foraminifera were formerly included *Eozoon*, *Dactylopora*, and *Receptaculites*; but the first-named is now generally considered to be inorganic, the second has been shown to be a calcareous alga, and the last is probably a sponge. (See p. 121.) **Wall-case 9.**

Foraminifera are of considerable geological importance. They are represented in most of the calcareous rocks from the Ordovician age to the present; but their remains are of somewhat rare occurrence in the Ordovician, Silurian, and Devonian formations. In the Carboniferous Limestone they are very abundant, and certain limestones are mainly composed of the remains of *Fusulina*, *Saccammina*, and *Endothyra*, and these genera are accompanied by *Nodosaria*, *Dentalina*, and representatives of the Textularidæ, Rotalidæ, and also the Nummulitidæ.

The calcareous marls and shales of the Lias and Jurassic strata contain immense numbers, mostly of the small perforate

**GALLERY X.**
**Wall-case 9, Table-case 16.**

and arenaceous forms. Perhaps the best-known example of a foraminiferal limestone is the White Chalk which is found over large areas of this country, France, Ireland, and Denmark. It is largely formed of the entire and fragmentary tests of numerous genera of microscopic Foraminifera, of which the most common are *Globigerina*, *Textularia*, *Rotalia*, and *Nodosaria*.

In the Tertiary rocks also many extensive limestone strata are principally composed of Foraminifera, as, for example, the *Miliola* limestone of the Paris Basin and the South of France; other Eocene limestones are filled with the tests of *Alveolina*, *Orbitolites*, and *Orbitoides*; but by far the most noted are the Nummulitic limestones of the Mediterranean area, the Carpathians, Hungary, Crimea, Egypt, Persia, and India (Fig. 182).

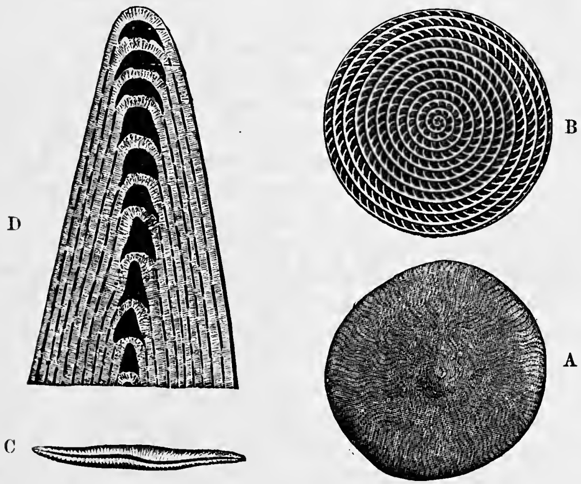



Fig. 182.—*Nummulina nummularia*, D'Orb. *A*, the shell viewed externally. *B*, the same horizontally bisected. *C*, the same vertically bisected. *D*, vertical section of part of the shell, highly magnified, showing the chambers of the median plane, the alar prolongations, and the tubuli of the shell substance. Eocene Tertiary. (Nicholson's Palæontology.)

Recent deep-sea explorations have proved that beds of Foraminifera analogous to those of the Chalk are now being formed over wide areas of the sea-bottom.

In the upper portion of the Wall-case 9 there is a series of models of 100 different forms of Foraminifera, prepared by

D'Orbigny, and a supplementary series of the same number by Reuss and Fritsch, which clearly illustrate the variety of form in the different members of the group; and adjoining these is an ideal model of a *Nummulite*, after Zittel, showing the structure in a longitudinal and transverse section. On the rest of this shelf are specimens of Nummulitic limestone from the Eocene strata of Scinde and from the Bracklesham beds of Sussex; also of *Orbitoides* and *Alveolina* limestones from Persia and India. **GALLERY X.** **Wall case 9, Table-case 16.**

In the middle shelf of the wall-case are Foraminifera, and rocks containing them, from foreign localities. The formations represented range from the Carboniferous Limestone to the Miocene Tertiary. Attention may be called to the specimens of *Nummulites* from Egypt, Biarritz, and the large forms from Kressenberg in Bavaria; to the *Orbitoides* from the Maestricht Chalk, and the peculiar *Calcarina* associated with them. On the lower shelf of the wall-case are other specimens of Nummulitic, *Orbitoides*, and *Heterostegina* limestones, and of Upper Greensand rock with *Patellina*.

In Table-case 16 are the specimens of Foraminifera from British strata, but on account of their small dimensions they can hardly be distinguished without a lens. Large numbers have been obtained by washing from the London Clay, and from the Coralline Crag of Pliocene age from Suffolk.

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## VEGETABILIA.

**Plantæ.**

### PLANTÆ.

The remains of fossil plants occupy the whole eastern side of Gallery X. The British specimens are arranged in the table-cases, foreign specimens on the sloping shelf of the wall-cases, larger British and foreign plants on the horizontal shelves of the wall-cases. In the cases arranged down the middle of the gallery there are various examples of plants from British and foreign localities. Beginning with the oldest known plants, there are a few specimens in Table-case 32 and the Wall-case 18 illustrating our very meagre knowledge of the flora of the Silurian epoch. A number of algæ-like impressions from the Wenlock Limestone of **GALLERY X.** **Wall-cases 10-18, Table-cases 17-32.**

GALLERY X. Wall-case 18, Table-case 32.

Dudley and other localities are of extremely doubtful affinity; probably some of these should be included in the Animal Kingdom. The genera *Nematophycus* and *Pachytheca* are of some interest as being the oldest fossils described as plants in which the internal structure has been preserved; the former was probably a large seaweed, but the nature of the latter is more doubtful. The genus *Berwynia*, from Corwen (North Wales), is in all probability a mineral structure, and not the remains of any organism.

In the same cases there are some excellent specimens of the oldest known British fern, *Palæopteris Hibernica*, from the Devonian rocks of Kiltorkan, near Waterford. The genus *Psilophyton*, especially characteristic of the Devonian strata of Canada, is represented by several imperfect examples: the true nature of this plant is not certainly known. In Table-cases 31 to 26, and in the Wall-cases 15 to 18, there is a very good series of fossils illustrating the more characteristic and striking plants of the UPPER CARBONIFEROUS forests. The large polished section of a tree (*Araucarioxylon*) between the Wall-cases 16 and 17, was cut from the tall stem standing in the grounds of the Museum, and found many years ago in a sandstone quarry at Craigleith, near Edinburgh. In anatomical structure the stem resembles fairly closely the living genus *Araucaria*, and was possibly the trunk of the extinct genus *Cordaites*. Thin sections of the wood of this tree are shown in Table-case 31. Casts of the discoid pith of *Cordaites*, formerly described as a separate genus, *Sternbergia*, or *Artisia*, are among the common Coal-measure fossils; the collection also includes several of the long and parallel-veined leaves and flowers of this genus. The common genera *Lepidodendron* and *Sigillaria* are abundantly represented; the well-known *Stigmaria* is generally regarded as the root of these trees, and is especially characteristic of the underclays of the Coal-measures. The cones of the former genus are known as *Lepidostrobus*, and are frequently met with in the shales and ironstones. The genera *Ulodendron* and *Halonia* represent cone-bearing branches of Lepidodendroid plants.

Wall-cases 15-18, Table-cases 31-26.

In some of the table-cases a few microscopic slides are exhibited, illustrating the wonderful perfection in which many of the Coal-period plants have had their minute structure preserved. From an examination of their anatomy it has been found that many of the forest trees in the Carboniferous period were near allies of our small living Lycopodiums ("club-mosses"), Equisetums

**GALLERY X. Wall-cases 15-18, Table-cases 28-26.**

("horse-tails"), and other similar plants. Another common genus of the same age is *Calamites*, which is usually found in the form of ribbed casts of the hollow pith of the stem; cones and leafy branches of *Calamites* are by no means rare, and are known as *Calamostachys*, *Asterophyllites*, *Calamocladus*, etc. Among the ferns may be mentioned the genera *Neuropteris*, *Alethopteris*, *Sphenopteris*, *Pecopteris*, and others, of which good examples are exhibited in the table- and wall-cases. In Table-case 28 a few specimens may be noticed under the name *Spiropteris*, showing the circinate vernation characteristic of fern fronds. On the under-side of the fossil fronds remains of sori and sporangia are occasionally met with, and by a microscopical examination of these it has been found that many of the Coal-measure ferns are nearly related to a few surviving tropical genera included in the family *Marattiaceæ*. Some good specimens of *Sphenopteris* and other genera from the Carboniferous Limestone of Rhyl are shown in Table-case 27. Another interesting genus of Coal-measure plants is *Sphenophyllum*, with its whorls of wedge-shaped leaves, attached to a comparatively slender stem. Thanks to the mineralization of the tissues of fragments of the stems, leaves, roots, and fructification, we possess a fairly complete knowledge of its histological structure; its exact botanical position is, however, not absolutely settled, and it occupies a somewhat isolated position among Palæozoic Cryptogams.

The curious fossils from Dudley known as *Palæoxyris*, shown in Table-case 31, have long been a puzzle to palæontologists; but are now regarded by many as the egg-cases of fishes.

In Table-case 26 and Wall-case 15, a few PERMIAN plants are exhibited; among these the silicified stems of tree-ferns from Saxony and other districts are of special interest. The characteristic Permian fern *Callipteris* is represented by a few specimens, also the large species of *Calamites*.

In Wall-cases 15 and 16 there are some examples of the fern-like plant *Glossopteris*, a genus widely distributed in Upper Palæozoic and Lower Mesozoic rocks of the southern hemisphere, and which gives its name to the *Glossopteris* flora of India, Australia, Africa, and South America.

Of TRIASSIC plants there are but few examples. In Wall-case 15 will be found some large specimens of sandstone casts of *Equisetites* from the German Trias; this plant seems to have had the form

GALLERY X. Wall-cases 13 & 14, Table-cases 25–21.

and habit of growth of a very large *Equisetum*. In the flora of the Triassic period the Cycads become more conspicuous; in the Permian and Carboniferous rocks very few specimens have been found. The family of the *Cycadaceæ*, represented at the present time by *Cycas*, *Zamia*, *Encephalartos*, and other genera confined to tropical regions, was in former ages very widely distributed. In the Jurassic rocks of the Yorkshire coast and elsewhere, the pinnate leaves of cycads are exceedingly numerous; good examples of these are shown in Table-cases 25, 24, and 23, and in Wall-cases 13 and 14. Numerous ferns and conifers are also exhibited among the Jurassic plants; among the former the genus *Matonidium* is of special interest in that it agrees very closely with *Matonia pectinata*, a fern now confined to Mount Ophir in the Malacca Peninsula. Of the Conifers the genus *Ginkgo* (*Salisburia*), which survives at the present day only in China and Japan, is represented by numerous fossil leaves agreeing in form with those of the single living species. A few specimens of cycads and conifers from the Lias of Lyme Regis are shown in Table-case 25 and Wall-case 13; also, against the pier between Wall-cases 13 and 14, a large branch of a conifer lying in a bed of shale, containing numerous Ammonites.

Passing to the Wealden plants in Table-cases 22 and 21 and Wall-case 13, we find a striking similarity, as regards the general character of the specimens, with those from Jurassic rocks. Several exceptionally fine examples of cycadean leaves and other plants have recently been acquired from Mr. P. Rufford, of Hastings, by whom they were obtained from Wealden strata on the Sussex coast. By far the finest specimen of a cycadean stem hitherto found in a fossil state in England is the *Cycadeoidea gigantea*, placed between Wall-cases 13 and 14, recently found in the Purbeck rocks of Portland. The preservation of the apical bud is a feature of particular interest. The genus *Bennettites* is of great importance from a botanical point of view; the stems of this plant exhibit an exceedingly perfect internal structure, also the inflorescence and seeds containing small embryos. The peculiar fossils from Jurassic and Wealden rocks known as *Williamsonia* are probably detached inflorescences of this plant. Whilst agreeing with cycads in many respects, it differs from them especially in the nature of its inflorescence.

In Cretaceous rocks above the Wealden beds plants are by no

means common in England. A few specimens of wood are shown in Table-case 20, and some examples of a supposed alga, which, like many of the so-called fossil seaweeds, may be an entirely inorganic structure. It was during the Cretaceous period that the highest class of plants, the Angiosperms (Monocotyledons and Dicotyledons), began to play a conspicuous part in the vegetation of the world. In England we find numerous examples of these plants in the still more recent TERTIARY rocks; the London Clay of Sheppey, the leaf-beds of Alum Bay, Bournemouth, and other places, have afforded numerous specimens of flowering plants. These are shown in Table-cases 19, 18, and 17, and in Wall-case 12. A large palm-leaf from Bournemouth, over a yard in length, affords a striking illustration of the subtropical character of the flora of Tertiary Britain. The fossil fruits from Sheppey known as *Nipadites*, are very similar in appearance to those of the living genus *Nipa*, one of the palms, of which the fruits are carried down in great numbers by the waters of the Ganges and other rivers, as in Tertiary times similar fruits were swept along by the waters of a river, of which the delta is in part represented by the London Clay of the Isle of Sheppey. Among other Tertiary plants may be mentioned the splendid slab from Mull, with large leaves like those of the recent plane-tree; also a collection of leaves brought by Mr. Edward Whymper from Greenland, and described by the late Oswald Heer; pieces of wood from Disco Island, and several good examples of Austrian plants from Styria and other places. In addition to the leaves of Angiosperms from Tertiary beds, fragments of coniferous trees and detached cones, also a few fern fronds, are represented in the Museum collection. Of still more recent date may be mentioned specimens of nuts, cones, etc., from the POST-TERTIARY beds of Norfolk; also large masses of *Chara*, in Wall-case 10, incrusted with carbonate of lime, and foreign specimens of travertin containing distinctly preserved leaf impressions.

**GALLERY X.**

**Wall-cases 12 10, Table-cases 20–17.**

In the middle of the gallery will be found some exceedingly fine examples of Coal-measure plants from Radstock, in Somersetshire, presented by James McMurtrie, Esq., F.G.S. In other cases are shown specimens of silicified coniferous and angiospermous wood from the Upper Jurassic rocks of Portland, from Tertiary strata in Antigua, and other places.

**Glazed-cases b–e.**

A fine opalized tree from Tasmania, a series of silicified woods

GALLERY X. from various localities, a large trunk of a tree from the Purbeck beds, Isle of Portland, and several *Sigillaria* stems from the Coal-measures, are arranged along the centre of this Gallery.

## DEEP-SEA DEPOSITS.

Table-case near the centre of Gallery X. In the centre of Gallery X, there has been temporarily placed a case containing a large series of deep-sea deposits, obtained during the cruise of H.M.S. "Challenger," which have been examined and described by Dr. John Murray, F.R.S., and the Rev. A. Renard. They consist of nodules of manganese, associated with bones and teeth of fishes and Cetacea, and also a large series of Foraminifera, etc.; they have a peculiar interest as giving us a clue to the mode of formation of ancient geological marine deposits containing similar remains to those now met with in dredging in the abysses of the Atlantic and Pacific Oceans.

## HISTORICAL AND TYPE COLLECTIONS, STRATIGRAPHICAL SERIES, ETC.

GALLERY XI. In Gallery XI has been arranged, in seventeen cases, a series of nine collections of historical and palæontological interest, bearing upon the early history of the British Museum and the study of Geology and Palæontology in this country.

Sir Hans Sloane's Collection, 1753. Table-case 16. Taking the exhibition cases in chronological order, the earliest is the Sloane Collection. This is the most ancient portion of the Geological series, having formed a part of the Museum of Sir Hans Sloane, Bart., F.R.S., acquired by purchase for the nation in 1753.

The geological collection is stated to have consisted "of what by way of distinction are called *extraneous fossils*, comprehending petrified bodies, as trees, or parts of them; herbaceous plants [the botanical and zoological specimens are now preserved in their respective Departments], animal substances," etc.; and reported to be "the most extensive and most curious that ever was seen of its kind." Until 1857 the fossils and minerals formed one collection, so that a large part of the Sloane Collection consisted probably of mineral bodies, and not *organic*; but in any case only about 100 specimens of invertebrate fossils can now be identified with certainty as forming part of the original Sloane Museum. Each specimen in the Sloane Collection

had originally a number attached to it, corresponding to a carefully-prepared manuscript catalogue, still preserved, which contains many curious entries concerning the various objects in the Museum. In the course of more than 140 years, many of these numbers have become detached from the objects or obliterated by cleaning. But as all fossils at this early date were looked upon *merely as curiosities*, but little attention was paid to the formation or locality whence they were derived. Historically, the collection has immense interest to us, marking the rapid strides which the science of Geology has made of late years, especially as regards its more careful and systematic methods of study.

**GALLERY XI.**

The next collection in chronological order is the Brander Collection, and is the earliest one in which types of named and described species have been preserved.

**Brander Collection, 1766.**

**Table-case 16.**

This collection was formed by Gustavus Brander, F.R.S., F.S.A., in the earlier half of the last century; and an account of the same, with eight quarto plates, was published in 1766, entitled, "Fossilia Hantoniensia Collecta, et in Musæo Britannico deposita, a Gustavo Brander, 1766." The descriptions of the species given in the work were written by Dr. Solander, one of the officers of the British Museum. They were "collected in the county of Hampshire, out of the cliffs by the sea-coast between Christchurch and Lymington, but more especially about the cliffs by the village of Hordwell, nearly midway betwixt the two former places" (*op. cit.*, p. 111).

Only a small proportion of the original 120 figured specimens are now capable of being identified, the rest having become, in the course of 130 years, commingled with the far more numerous and later Eocene Tertiary acquisitions, and so have lost their connection with this admirable memoir. The engravings of the shells are equal to any modern published work descriptive of the fossils of the Eocene formation; but the names given by Dr. Solander are in many instances incorrect, according to our present knowledge of the genera of Mollusca.

**Dr. Wm. Smith's Collection, 1816–8.**

**Centre-case, East Wall.**

The next series to which attention is directed, is the collection of William Smith, LL.D. This was commenced about the year 1787, and purchased by the Trustees in 1816, a supplemental collection being added by Dr. Smith in 1818.

It is remarkable as the first attempt made to identify the various strata forming the solid crust of England and Wales by

**GALLERY XI.**

means of their fossil remains. There had been other and earlier collections of fossils, but to William Smith is due the credit of being the first to show that each bed of chalk or sandstone, limestone or clay, is marked by its own special organisms, and that these can be relied upon as characteristic of such stratum, whenever it is met with, over very wide areas of country.

The fossils contained in this cabinet were gathered together by William Smith in his journeys over all parts of England during thirty years, whilst occupied in his business as a land surveyor and engineer, and were used to illustrate his works, "Strata identified by Organized Fossils," with coloured plates (quarto, 1816; four parts only published), and "Stratigraphical System of Organized Fossils" (quarto, 1817).

**William Smith's Map, 1815.**

A coloured copy of his large Map, the first Geological Map of England and Wales, with a part of Scotland, commenced in 1812 and published in 1815—size 8 feet 9 inches by 6 feet 2 inches, engraved by John Cary—is exhibited on the right-hand side of this gallery, near the entrance. A reduced copy of this map and several sections across England, published by Smith in 1819, are also placed upon the wall near his bust.

William Smith was born at Churchill, a village of Oxfordshire, in 1769; he was the son of a small farmer and mechanic, but his father died when he was only eight years old, leaving him to the care of his uncle, who acted as his guardian. William's uncle did not approve of the boy's habit of collecting stones ("pundibs" = *Terebratulæ,* and "quoit-stones" = *Clypeus sinuatus*); but seeing that his nephew was studious, he gave him a little money to buy books. By means of these he taught himself the rudiments of geometry and land-surveying, and at the age of eighteen he obtained employment as a land-surveyor in Oxfordshire, Gloucestershire, and other parts, and had already begun carefully and systematically to collect fossils and to observe the structure of the rocks. In 1793 he was appointed to survey the course of the intended Somersetshire Coal-Canal, near Bath. For six years he was the resident engineer of the canal, and, applying his previously acquired knowledge, he was enabled to prove that the strata from the New Red Marl (Trias) upwards followed each other in a regular and orderly succession, each bed being marked by its own characteristic fossils, and having a general tendency or "dip" to the south-east.

To verify his theory Smith travelled in subsequent years over the greater part of England and Wales, and made careful observations of the geological succession of the rocks, proving also, by the fossils obtained, the identity of the strata over very wide areas along their outcrops. **GALLERY XI.**

His knowledge of fossils advanced even further, for he discovered that those *in sitû* retained their sharpness, whereas the same specimens derived from the drifts or gravel-deposits were usually rounded and water-worn, and had reached their present site by subsequent erosion and transportation of portions of the parent rock.

Mr. Smith received the award of the *first* Wollaston Medal and fund in 1831, from the hands of Professor Sedgwick, the President of the Geological Society—"As a great original discoverer in English geology, and especially for his having been the first, in this country, to discover and teach the identification of strata, and to determine their succession by means of their imbedded fossils."

In June, 1832, the Government of H.M. King William IV awarded Mr. Smith a pension of £100 a year, but he enjoyed it only for seven years, as he died 28th August, 1839.

In 1835 the degree of LL.D. was conferred upon Mr. Smith by the Provost and Fellows of Trinity College, Dublin. The highest compliment paid him was that by Sedgwick, who rightly named him "the Father of English Geology."

The bust above the case which contains William Smith's collection is a copy of that by Chantry, surmounting the tablet to his memory in the beautiful antique church of All Saints, at Northampton, where his remains lie buried.

**Sowerby's Mineral Conchology, 1812–45. Wall-case 6, Table-cases 10–12.**

We come next to a collection the very name of which betrays the antiquity of its origin. It is known as Sowerby's "Mineral Conchology."

This collection was begun by James Sowerby prior to 1812, and continued by his son, James de Carle Sowerby, F.L.S., during the preparation of their great work, entitled "The Mineral Conchology of Great Britain," which appeared in parts between June, 1812, and December, 1845, and forms a work of six volumes octavo, illustrated with 648 plates.

The value of this work consists in the fidelity and accuracy of the figures given, and also in the fact that most of the specimens drawn are here named and described for the first time. They

GALLERY XI. comprise fossils from all parts of England and from every geological formation.

The small green labels mark the specimens actually figured in the work. The collection was purchased by the Trustees of the British Museum from Mr. J. de Carle Sowerby, January, 1861.

It may be interesting to record that many of the latter parts were illustrated by plates drawn by the late J. W. Salter, A.L.S., F.G.S., for so many years palæontologist to the Geological Survey. When a youth, Salter was apprenticed to J. de Carle Sowerby, who was at that time both a naturalist and an engraver. The youthful apprentice afterwards married his master's daughter, and became, as is well known, one of the most brilliant palæontologists in this country.

Another curious but small series represents the "types" or "figured specimens" of König's "*Icones Fossilium Sectiles.*"

König's Icones, 1825.

This illustrated work, on miscellaneous fossils in the British Museum, was prepared by Mr. Charles König, the first Keeper of the Mineralogical and Geological Department, after its separation from the General Natural History collections in 1825.

Table-case 16.

The engravings are rough, but characteristic, and the first "century" (or 100 figures of fossils) is accompanied by descriptions; the plates of the second "century" have names only, and no descriptions are published with them.

Gilbertson Collection, 1836.

A far more important collection is that known as the Gilbertson Collection.

Table-cases 15 & 16.

In 1836 Professor John Phillips published vol. ii of his "Illustrations of the Geology of Yorkshire," which is devoted to the "Mountain Limestone District." In the Introduction he writes as follows:—"My greatest obligation is to Mr. Wm. Gilbertson, of Preston, a naturalist of high acquirements, who has for many years explored with exceeding diligence a region of Mountain Limestone, remarkably rich in organic remains. The collection which he has amassed from the small district of Bolland is at this moment unrivalled, and he has done for me, without solicitation, what is seldom granted to the most urgent entreaty; he has sent me for deliberate examination, at convenient intervals, the whole of his magnificent collection, accompanied by remarks dictated by long experience and a sound judgment." Gilbertson had proposed to publish on the *Crinoidea* himself, but his sketches, as well as his specimens, were all placed at Professor Phillips' disposal.

Phillips adds—"An attentive examination of this rich collection rendered it unnecessary to study minutely the less extensive series preserved in other cabinets . . . . most of the figures of fossils are taken from specimens in Mr. Gilbertson's collection, because these were generally the best that could be found." The Gilbertson Collection was purchased for the British Museum in 1841.

**GALLERY XI.**

The collections which follow mark a distinct era in the annals of Geological Science.

**The London Clay Club, 1838.**

Nearly sixty years ago a little Society was founded by a few London geologists, namely — Dr. J. Scott Bowerbank, F.R.S., Searles V. Wood, F.G.S., Prof. John Morris, F.G.S., Alfred White, F.L.S., Nathaniel T. Wetherell, F.G.S., James de Carle Sowerby, F.L.S., and Frederick E. Edwards, F.G.S., for the purpose of illustrating the Eocene Mollusca, and entitled the "London Clay Club."

**Palæontographical Society, 1847.**

They met at stated periods at each other's houses, and after a time they said, "Why should we not illustrate all the fossils of the British Islands, and from every formation?" No sooner proposed than a Society was founded, named the Palæontographical Society, in the year 1847 (fifty years ago). The first volume, issued in that year, was "The Crag Mollusca, Part I: Univalves"; by Mr. Searles V. Wood, F.G.S. (with 21 plates).

**Searles V. Wood's Crag Mollusca, 1826-56.**

**Table-cases 1-3.**

Here is preserved the actual Searles Wood Crag Collection. This collection was commenced in 1826, and occupied about thirty years in its formation. It represents the Molluscan fauna of the Red and Coralline Crags of the neighbourhood of Woodbridge, and from Aldborough, Chillesford, Sudbourn, Orford, Butley, Sutton, Ramsholt, Felixstow, and many other localities in Suffolk, also from Walton-on-the-Naze in Essex. The specimens so collected were employed by Mr. Searles Wood in the preparation of his monograph on the Crag Mollusca, published by the Palæontographical Society (1848–61), with Supplements in 1871, 1873, and 1879, illustrated by seventy-one quarto plates. Each figured specimen is indicated by a small green label affixed to it.

A geological description of the Crag formation by Mr. S. V. Wood, jun., F.G.S, and Mr. F. W. Harmer, was issued by the Palæontographical Society in 1871 and 1873.

The collection was presented by Mr. S. V. Wood to the British Museum, January, 1856, and a supplementary collection was given by Mrs. Searles V. Wood in 1885.

**GALLERY XI.**

**F. E. Edwards' Eocene Mollusca, 1835–73.**

The next palæontographical collection is of nearly equal antiquity, and fully of equal merit. It is the Eocene Molluscan collection formed by the late Mr. Frederick E. Edwards, F.G.S., about the year 1835, and was continually being added to, until a few years before his death, which happened in 1875. It was acquired for the nation by purchase in 1873.

**Table-cases 3–9.**

Originally intended to illustrate the fossils of the London Clay, Mr. Edwards extended his researches over the Eocene strata of Sussex, Hampshire, and the Isle of Wight, where, assisted by Mr. Henry Keeping, he made the most complete collection ever attempted by any geologist, and it still remains unrivalled.

Mr. Edwards contributed six memoirs to the Palæontographical Society, 1848–1856; also separate papers to the London Geological Magazine, 1846, The Geologist, 1860, and the Geological Magazine, 1865, descriptive of the Eocene Mollusca in his collection.

Mr. S. V. Wood continued the work for Mr. Edwards, describing and figuring the Eocene Bivalves in the annual volumes of the Palæontographical Society for 1859, 1862, 1870, and 1877. Each specimen which has been figured is specially marked.

About 500 species have been described and figured, but the collection is very rich in new and undescribed forms.

**The Davidson Collection of Brachiopoda, 1837–86.**

The last collection is that of a naturalist who devoted his entire life to the study and illustration of a single class of organisms, namely, the Brachiopoda. It was formed by the late Thomas Davidson, LL.D., F.R.S., F.G.S., V.P. Pal. Soc., etc. (of West Brighton, and Muir House, Midlothian), between the years 1837 and 1886, with the object of illustrating his great work on the British Fossil Brachiopoda, published by the Palæontographical Society, in six quarto volumes, between the years 1850 and 1886, comprising 2,290 pages of text and 234 plates, with 9,329 figures and descriptions of 969 species.

Dr. Davidson was also the author of the Report on the Brachiopoda collected by H.M.S. "Challenger" (vol. i, 1880); of the article "Brachiopoda" in the Encyclopædia Britannica, ninth edition, 1875; of a Monograph of Recent Brachiopoda (Trans. Linnæan Society, 1886 and 1887); and of more than fifty other separate memoirs mostly bearing upon Brachiopoda, both recent and fossil, printed in the Transactions and Journals of the various learned societies.

Dr. Davidson's collection, both of recent and fossil Brachiopoda,

together with all his original drawings, his numerous books and pamphlets, were bequeathed by him to the British Museum through his son William Davidson, Esq., February, 1886. By his direction the entire collection of recent and fossil species is to be kept together in one series for the convenience of reference of all men of science who may wish to consult the same. **GALLERY XI. Table-cases 13–15.**

The Stratigraphical Collection of British sedimentary rocks (arranged and illustrated by Robert Etheridge, F.R.S. L. & E., F.G.S.) occupies Wall-cases 1–5, along the western side of Gallery XI, and is illustrated by a continuous section (placed at the top of the case) showing the succession of the sedimentary deposits from the newest in the East to the oldest on the West coast; also by numerous small sections of the strata, observed and recorded by the Geological Surveyors and others, in different parts of England; and by a series of small maps, coloured to show the exposed area of each geological formation, and placed next the case containing the specimens which illustrate that formation.

**Paramoudras.**

Two fine examples of "pot-stones," or *Paramoudras*, are exhibited between Wall-cases 1 and 2. These curious masses of flint are from the Upper Chalk of Horstead, Norfolk, and were presented by the late John Gunn, Esq., F.G.S.

**Specimens of Cores from Borings.**

Between Wall-cases 3 and 4 are exhibited—(1) a core of New Red Sandstone obtained from the depth of 1,190 feet from the Newent boring for water, to supply the city of Gloucester; presented by R. Read, Esq., C.E. (2) A series of cores from the Dover boring for coal: that from 2,039 feet representing true coal, that from 2,088 feet being made up of coal and grey grit, that from 1,262 feet being grey grit and sandstone; presented by Francis Brady, Esq., Memb. Inst. C.E., F.G.S.

Between Wall-cases 4 and 5 is placed an example of Wenlock Shale obtained from the Ware boring, Hertfordshire, at a depth of 825 feet from the surface, by the New River Water Company in attempting to procure water for London.

Between Wall-cases 6 and 7 are placed two large cores of Carboniferous Limestone from the Spinney boring, Northampton; they were obtained at a depth of 805 feet and 828 feet respectively from the surface, and were presented by John Eunson, Esq., C.E., F.G.S.

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# BRITISH MUSEUM

## (NATURAL HISTORY),

*CROMWELL ROAD, LONDON, S.W.*

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## DAYS AND HOURS OF ADMISSION.

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The Exhibition Galleries are open to the Public, free, every week-day

| | | | | | |
|---|---|---|---|---|---|
| January, | from 10 A.M. | till 4 P.M. | | | |
| February, | ,, | ,, | ,, | 4.30 P.M. | |
| March, | ,, | ,, | ,, | 5.30 | ,, |
| April to August | ,, | ,, | ,, | 6 | ,, |
| September, | ,, | ,, | ,, | 5.30 | ,, |
| October, | ,, | ,, | ,, | 5 | ,, |
| November and December, | ,, | ,, | ,, | 4 | ,, |

Also from May 1st to the middle of July, on Mondays Saturdays only, till 8 P.M.;

and from the middle of July to August 31st, on Mondays Saturdays only, till 7 P.M.

The Museum is also open on Sunday afternoons throughout the year

The Museum is closed on Good Friday and Christmas Day.

By Order of the Trustees,

W. H. FLOWER,

*Director.*